TM 11-4007

WAR DEPARTMENT TECHNICAL MANUAL

RADIO TRANSMITTER

BC-653-A

REPAIR INSTRUCTIONS

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WAR DEPARTMENT • MAY 1945

TECHNICAL MANUAL

RADIO TRANSMITTER BC–653–A
REPAIR INSTRUCTIONS

TM 11–4007
CHANGES No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *11 January 1956*

TM 11–4007, 25 May 1945, is changed as follows:

The following information changes TM 11–4007 so that the manual also applies to the following equipment:

Nomenclature	*Order No.*
Dynamotor DY–96/VRC	15918-Phila-55

Add "or Dynamotor DY–96/VRC after "Dynamotor DM–43–A" in the following places in the manual:

Page 1, paragraph 1c, line 7.
Page 10, paragraph 10, line 8.
Page 34, paragraph 36b(4)(b), line 12.
Page 34, paragraph 36b(4)(c), line 8.

Page 1, paragraph 2, table I, column 3. After the heading, add: or DY–96/VRC.

Page 10, paragraph 9. Add the following after paragraph 9:

9.1. Dynamotor DY–96/VRC Resistance Measurements

The schematic diagram for Dynamotor DY–96/VRC is contained in figure 23.1. Important check points, to aid in locating trouble, are contained in table III.1 which follows.

Table III.1. Dynamotor DY–96/VRC Resistance Measurements

From	To	Resistance (ohms)
Pin 1 of plug P162	Pin 2 of plug P162	55 to 100[1]
Pin 1 of Plug P162	Pin 5 of plug P163	100 to 200[1]
Pin 3 of plug P162	Pin 4 of plug P163	Less than 1
Pin 4 of plug P163	Pin 6 of plug P163	2

[1] With respect to the position of the commutator.

Page 20, paragraph 26b(5). Add the following to subparagraph (5): When using Dynamotor DY–96/VRC, adjust the input voltage for 24 volts.

Page 25, paragraph 31a, line 8. After "12-volt battery," insert: (or a 24-volt battery when using Dynamotor DY–96/VRC).

Page 25, paragraph 31b, line 5. After "12-volt battery," insert: (or a 24-volt battery when using Dynamotor DY–96/VRC).

Page 39. Insert figure 23.1 after figure 23.

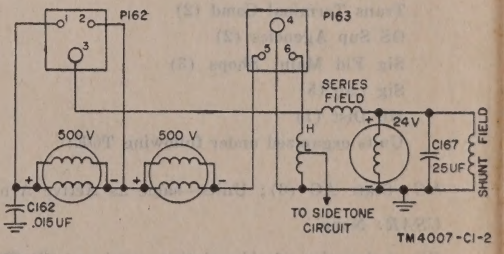

Figure 23.1. Dynamotor DY–96/VRC, schematic diagram.

Page 39. Insert figure 28 after figure 27.

[AG 300.7 (8 Dec 55)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

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Chief of Staff.

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Gen Depots (2) except Atlanta Gen Depots (None)
Sig Sec, Gen Depot (10)
Sig Depots (20)
Trans Terminal Comd (2)
OS Sup Agencies (2)
Sig Fld Maint Shops (3)
Sig Lab (5)
Mil Dist (1)
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5-215R (2)
5-216R (2)
5-217R (2)
5-218R (2)
5-312R (2)
5-315R (2)
5-316R (2)
6-300R (2)
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6-317R (2)
6-319R (2)
6-325R (2)
6-326R (2)
6-327R (2)
6-501R (2)
6-535R (2)
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7R (2)
7-25R (2)
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8-75R (2)
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11-7R (2)
11-16R (2)
11-57R (2)
11-127R (2)
11-128R (2)
11-500R (AA-AE) (2)
11-557C (2)
11-587R (2)
11-592R (2)
11-597R (2)
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17-2R (2)
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17-25R (2)
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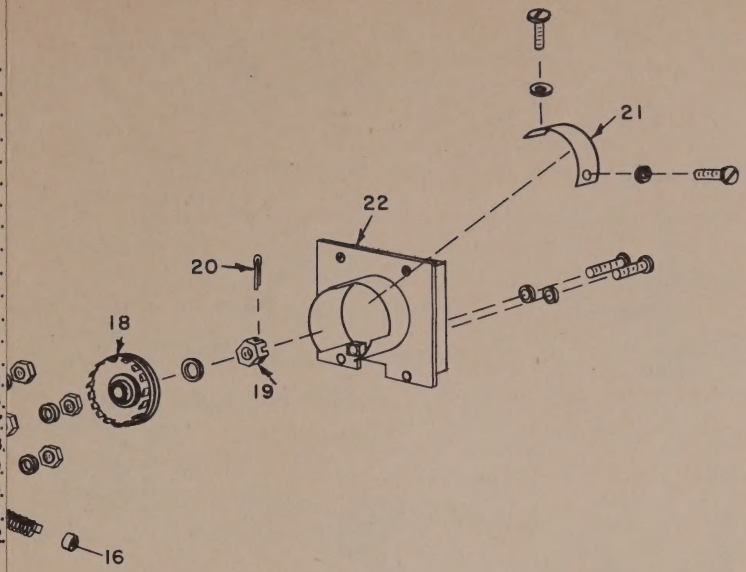
17-46R (2)
17-51R (2)
17-52R (2)
17-53R (2)
17-55R (2)
17-56R (2)
17-57R (2)
17-62R (2)
57R (2)

NG: State AG (6); Units—same as Active Army except allowance is one copy per unit.

USAR: None.

For explanation of abbreviations used, see SR 320-50-1.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[AG 300.7 (8 Dec 55)]

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17-62R (2)
57R (2)

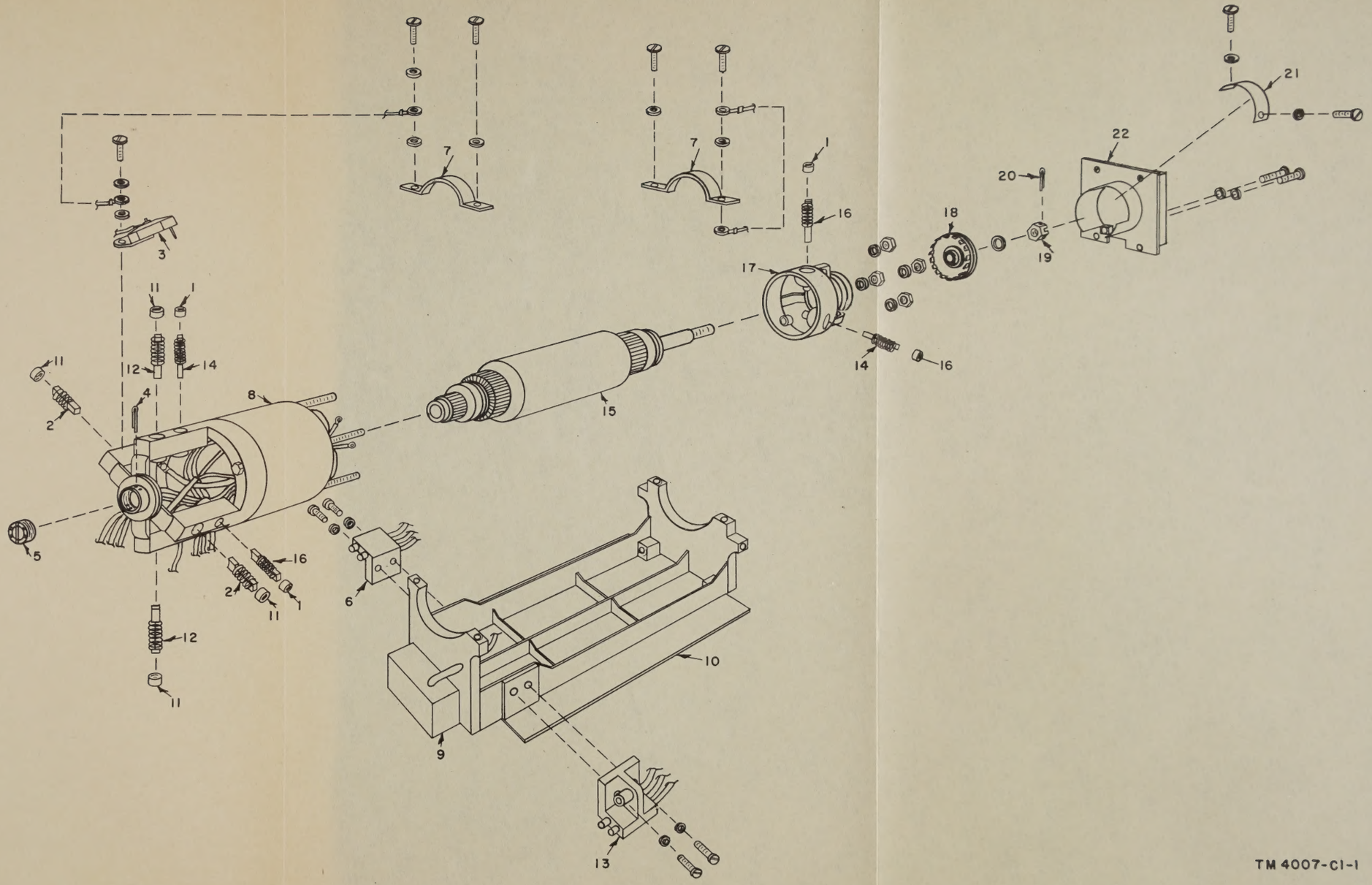
NG: State AG (6); Units—same as Active Army except allowance is one copy per unit.

USAR: None.

For explanation of abbreviations used, see SR 320-50-1.

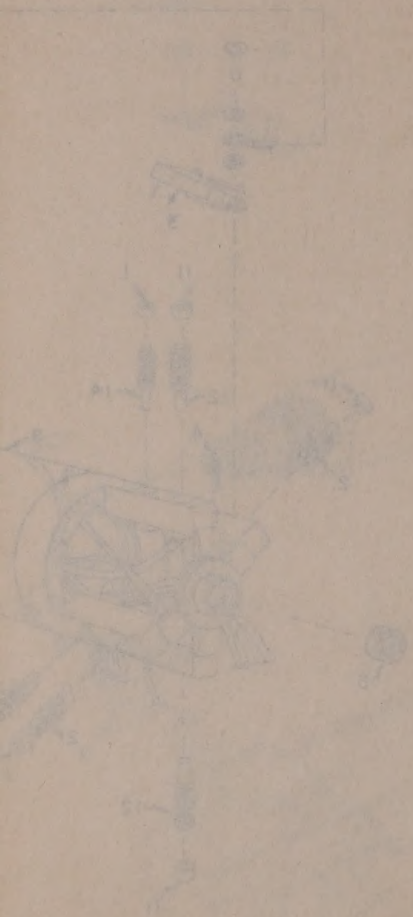
PARTS DESCRIPTION

1. HV BRUSH CAP O 162
2. NEGATIVE LV BRUSH ASSEMBLY E161
3. CAPACITOR C162
4. COTTER PIN
5. HV END SCREW
6. CONNECTOR P162
7. MOUNTING BRACKET
8. CASING ASSEMBLY
9. CAPACITOR C167
10. BASE ASSEMBLY
11. LV BRUSH CAP O 161
12. POSITIVE LV BRUSH ASSEMBLY E161
13. CONNECTOR P163
14. NEGATIVE HV BRUSH ASSEMBLY E162
15. ARMATURE
16. POSITIVE HV BRUSH ASSEMBLY
17. END BELL
18. FAN
19. KEYED CASTLE NUT
20. COTTER PIN
21. COVER PLATE
22. FAN HOUSING ASSEMBLY



TM 4007-C1-1

Figure 28. Dynamotor DY-96/VRC, exploded view.



RADIO TRANSMITTER

BC-653-A

REPAIR INSTRUCTIONS

AR DEPARTMENT TECHNICAL MANUAL

TM 11-4007

RADIO TRANSMITTER

BC-653-A

REPAIR INSTRUCTIONS

AR DEPARTMENT • *MAY 1945*

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United States Government Printing Office
Washington: 1945

WAR DEPARTMENT

WASHINGTON 25, D. C., 25 MAY 1945

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[AG 300.7 (3 May 45)]

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Refer to FM 21–6 for explanation of distribution formula.

WARNING

HIGH VOLTAGE

is used in the operation of
this equipment.

DEATH ON CONTACT

may result if safety precautions
are not observed.

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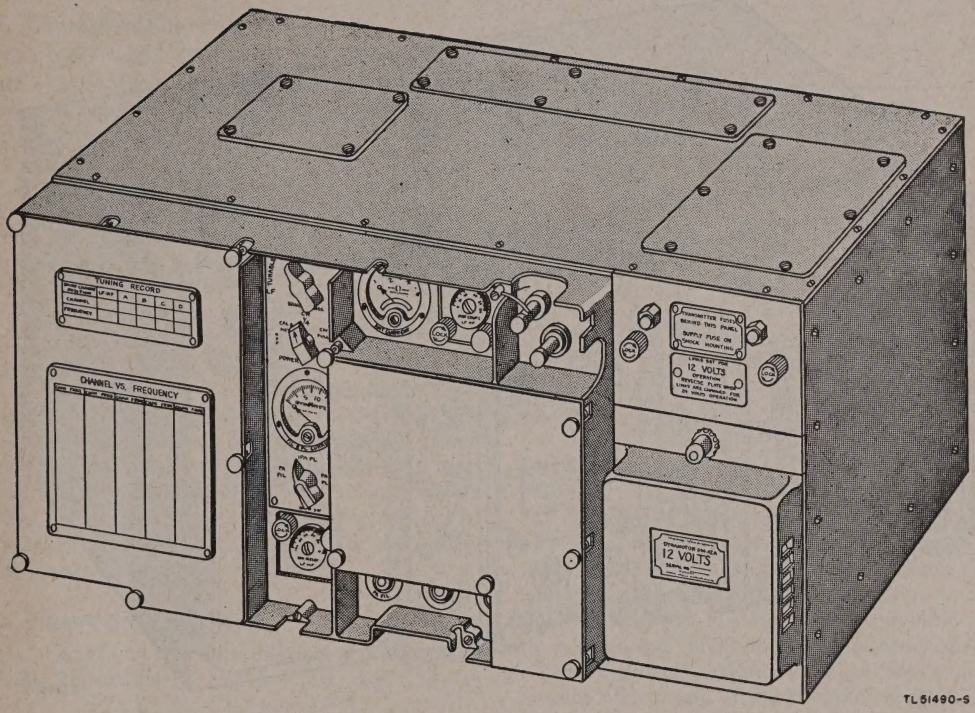


Figure 1. Front view, front covers on, Radio Transmitter BC–653–A.

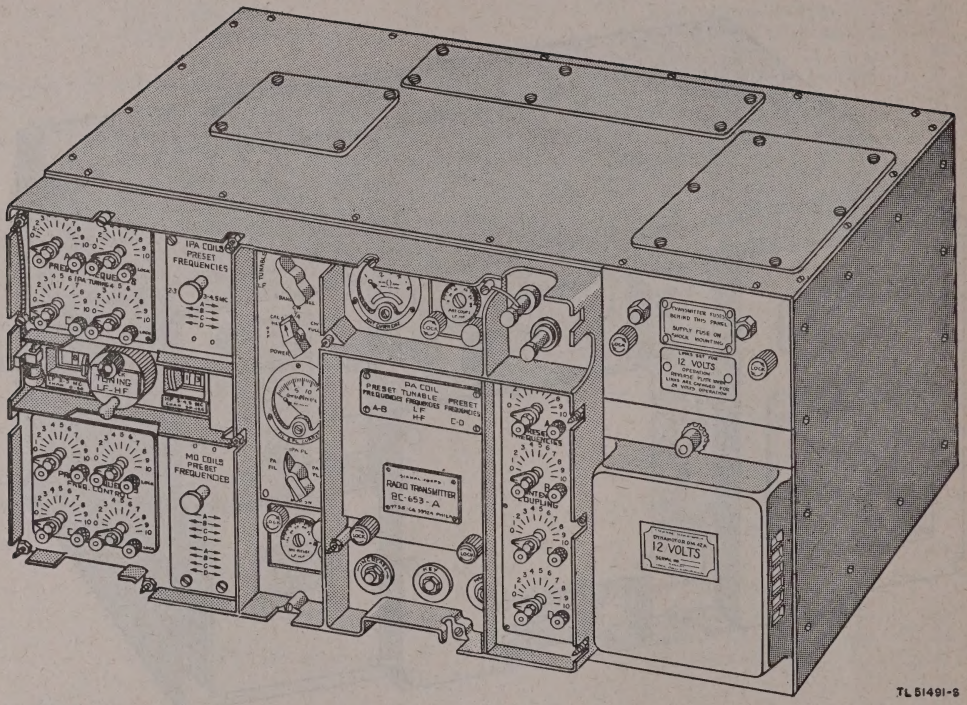


Figure 2. Front view, front covers off, Radio Transmitter BC–653–A.

SECTION I

DESCRIPTION OF RADIO TRANSMITTER BC–653–A[1]

1. Characteristics

a. USE. Radio Transmitter BC–653–A (figs. 1 and 2) is designed for installation in tanks and other vehicles, to provide continuous-wave (c-w) and voice communication between these vehicles and airplanes or base stations.

b. CHARACTERISTICS. The average range of Radio Transmitter BC–653–A is 25 miles on voice and 50 miles on continuous wave, depending on operating conditions, terrain, and radio sets contacted. It provides five selectable channels covering a frequency range of 2 to 4.5 megacycles (mc). Its carrier power varies from 50 to 90 watts on continuous wave, with one-quarter of this on voice.

c. POWER SOURCE. Power is supplied by either a 12-volt or a 24-volt vehicular battery. On the 12-volt battery, drain averages 39 amperes; on the 24-volt battery, 20 amperes. If a 12-volt supply is used, Radio Transmitter BC–653–A uses Dynamotor DM–42–A; if a 24-volt supply is used, the transmitter uses Dynamotor DM–43–A. The ratings of these dynamotors are given in table I.

2. Theory of Operation

a. GENERAL. The block diagram of the circuit of Radio Transmitter BC–653–A (fig. 3) shows the path

Table I. Electrical ratings of Dynamotors DM–42–A and DM–43–A

	DM–42–A	DM–43–A
Input voltage	12 volts	24 volts
Input current	39 amperes	20 amperes
Output voltage (500 volts)	460 volts	460 volts
Output current (500 volts)	185 ma	185 ma
Output voltage (1,000 volts)	925 volts	925 volts
Output current (1,000 volts)	220 ma	220 ma
Sidetone voltage* (full)	7 volts	7 volts
Sidetone voltage* (tap)	2 volts	2 volts

*Into 500-ohm load.

Note. Throughout this manual official nomenclature followed by ( ) indicates general reference to all models of the item of equipment.

[1] See TM 11–630 for installation, operation, and other maintenance data on this equipment.

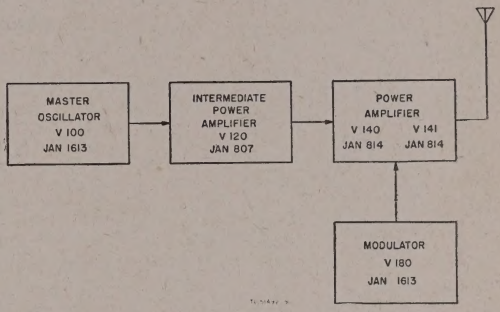


Figure 3. Block diagram, Radio Transmitter BC–653–A.

of the signal from the oscillator to the output at the antenna.

b. MASTER-OSCILLATOR STAGE. The master oscillator is an electron-coupled Hartley oscillator, which uses Tube JAN–1613 (V100). The master oscillator and the two succeeding amplifier stages are capable of being preset to four different frequencies in the range of 2 to 4.5 mc by means of links to tuning coils, and by means of four separate capacitors in each stage. In addition, variable tuning is provided over the whole range. The output of the master oscillator is coupled through capacitor C112 and resistor R123 into the control grid of the intermediate-power amplifier.

c. INTERMEDIATE-POWER-AMPLIFIER STAGE. The intermediate-power amplifier uses Tube JAN–807 (V120) and a tuned plate circuit. The output of the tuned plate circuit of tube V120 is capacitively coupled through capacitor C130 into the control grids of the power amplifiers.

d. POWER-AMPLIFIER STAGE. This stage consists of two Tubes JAN–814 (V140 and V141) in parallel with a common tuned plate circuit and antenna coupling. The power-amplifier (p-a) stage is modulated in the screen-grid circuit.

e. MODULATOR STAGE. This stage comprises a one-tube modulator, Tube JAN–1613 (V180), which can

be modulated by voice or key. Associated with the modulator are switching circuits and relays which accomplish such functions as: Providing 1,000-cycle sidetone for Radio Receiver BC–652–A during keying, providing voice sidetone during voice operations, grounding the antenna terminals of Radio Receiver BC–652–A during keying, and switching off Radio Transmitter BC–653–A in the intervals between voice or key modulation.

f. VOLTAGE REGULATOR. The voltage regulator is made up of two Tubes JAN–OC3/VR105 (V160 and V161). These tubes supply regulated 210-volt direct current to the plate and screen of tube V100, the master oscillator.

SECTION II

DIFFERENCES BETWEEN MODELS

Not applicable.

SECTION III

INITIAL REPAIR PROCEDURES

3. General

Note. Before any repairs or adjustments are made, all authorized modification work orders should be applied. Refer to War Department Pamphlet 12-6 for list of applicable MWO's.

Maintenance personnel should follow the procedure outlined in this manual when repairing and overhauling Radio Transmitter BC-653-A. The repair information in this and the following sections is presented in the order in which the repairman should actually perform the various operations on the equipment in the repair shop. This procedure permits repair of the equipment in the shortest time possible, resulting in accuracy and performance comparable to that of new equipment.

4. Tools, Test and Cleaning Equipment

The equipment listed in table II should be available for the proper repair of Radio Transmitter BC-653-A.

Table II.

Item	Description
Dental mirror.	
Assorted hand tools.	Soldering iron, pliers, screw drivers, assorted small socket wrenches, etc.
Flashlight or probing light.	
Solvent, Dry-cleaning.	
Assorted brushes.	
Compressed air.	Clean, dry, low-pressure.
Sandpaper.	Fine grade.
Crocus cloth.	
Oil, Lubricating, Special.	
Grease, lubricating, Special	
Grease, General Purpose No. 2.	
Lintless cloth.	
Dynamotor test set.	
Calibrated Radio Receiver BC-652-A.	
Short-wave receiver.	Range: 2.0 mc to 4.5 mc.
Mounting FT-253-A.	
Headset HS-28, HS-23-A, or HS-30-( ).	Equipped with Plug PL-55.

5. Removal of Parts

a. Preliminary. Remove the two covers over the panel controls on the front panel by loosening the five thumbscrews holding each cover. Remove the screws holding the outer shields on the left and right sides of unit and remove the shields. Remove the screws which hold the outer shields on the rear and top of unit, and remove the shields. Turn the two LOCK knobs on the front panel plate which hold the fuses and links, and remove the plate by pulling the knobs forward and down. Turn the two LOCK knobs which hold the PA COIL plate to the front panel and remove the panel by pulling the knobs forward and down. Loosen the two Dzus fasteners in the IPA COILS PRESET FREQUENCIES plate and the two in the MO COILS PRESET FREQUENCIES plate. Remove each plate from the panel by pulling it forward with the knob provided on the plate for this purpose. Remove the six screws from each of the two inner shields on the lower left-hand side of unit, and remove the shields. Remove the screws from the two inner shields on the back of the unit (on the lower right-hand side, viewed from the rear), and remove the shields. Loosen the three wingnuts on the bottom front of the unit and slide the unit forward on its mounting, thus disconnecting plug P161 from jack J161 on Mounting FT-253-A. Lift the transmitter off the mounting and set it on its right end. Remove the screws holding the bottom outer shield to the unit. Remove the two screws from each of the eight metal runners. Note that the runners are held by ⅜-inch steel screws and that the bottom shield is held by ½-inch brass screws. In reassembling, replace the screws in their proper positions. Remove the runners and the bottom shield. Remove the screws which hold the bottom aluminum inner shields to the frame and remove the three inner shields. Turn the set upright, and refer to figures 4, 5, and 6.

b. Dynamotor Assembly. Loosen the four unpainted screws which hold the dynamotor assembly

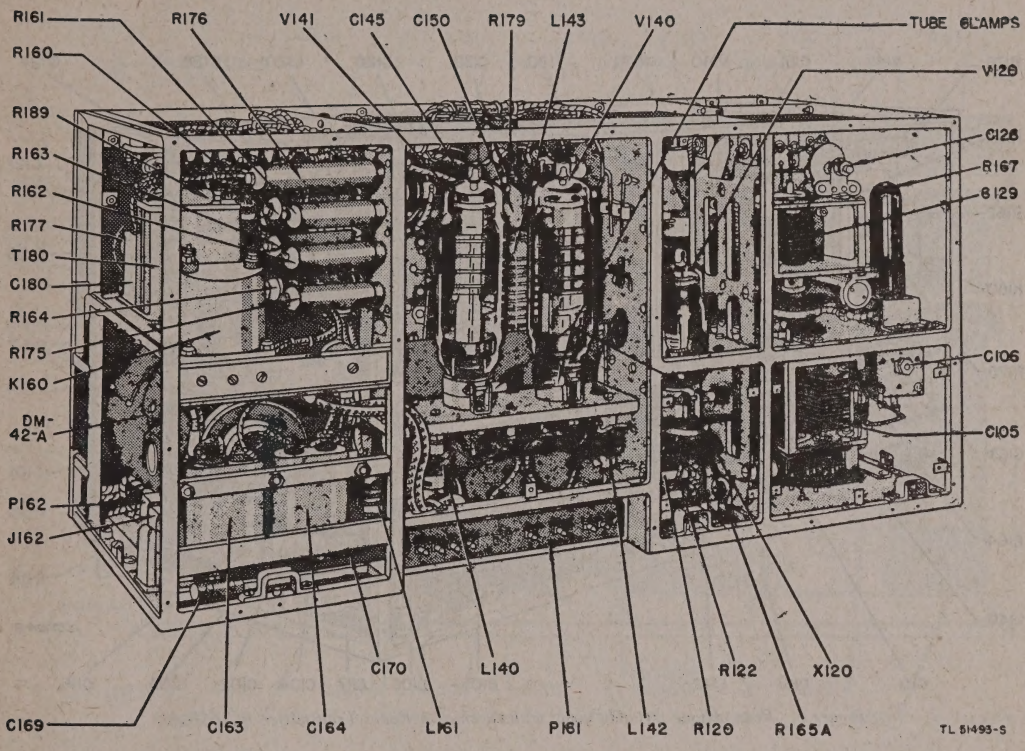


Figure 4. Rear oblique right-side view, without shields, Radio Transmitter BC–653–A.

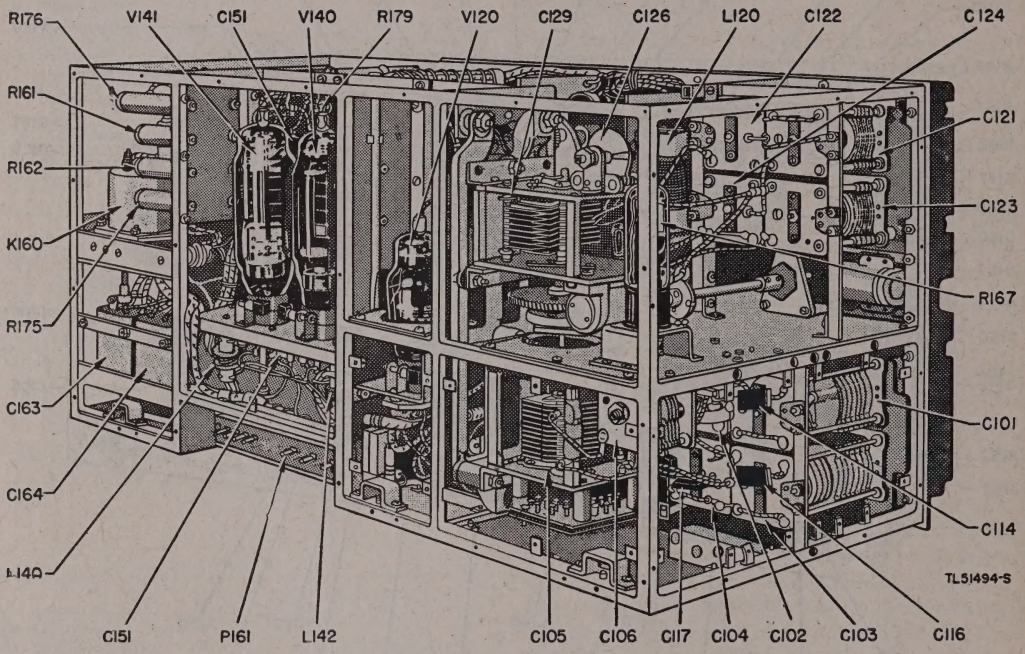


Figure 5. Rear oblique left-side view, without shields, Radio Transmitter BC–653–A.

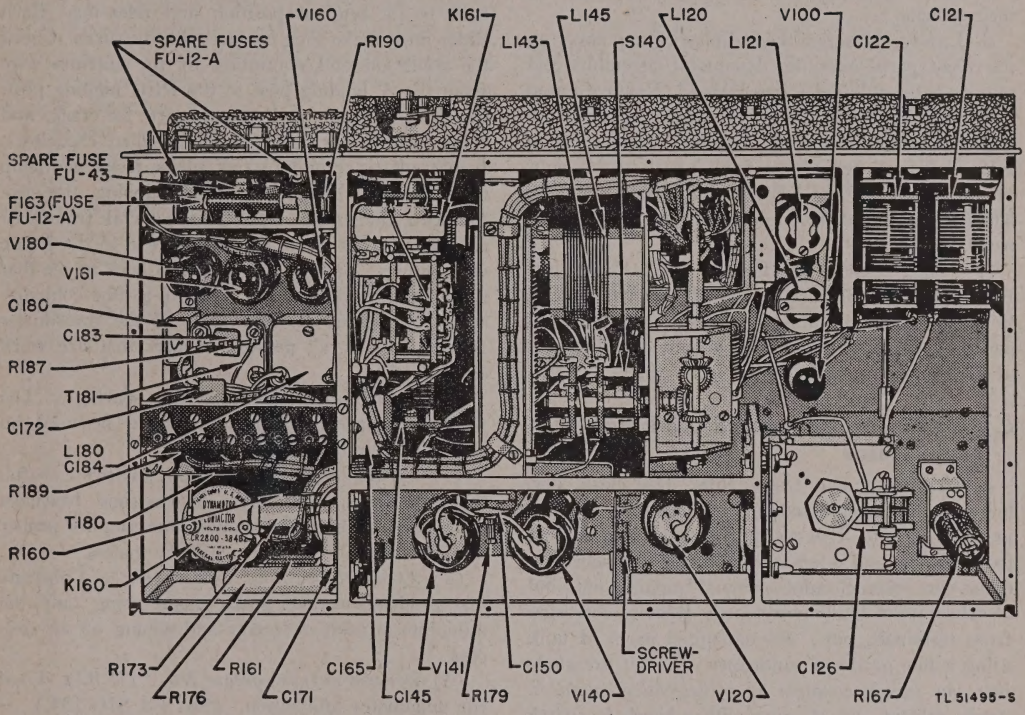


Figure 6. Top view, without shields, Radio Transmitter BC–653–A.

to the front panel. Slide the assembly forward, disconnecting plugs P162 and P163 of the dynamotor from jacks J162 and J163. Remove the two painted screws from the dynamotor panel shield and remove the shield.

c. TUBES. Remove the plate caps from tubes V140, V141, and V120. Loosen the clamps which hold these tubes in place by turning the clamps one-quarter turn counterclockwise. Use the long-bladed screwdriver located on the frame near tube V120. Remove the three tubes from their sockets, using a slight rocking motion. Remove the other five tubes from their sockets.

d. LAMPS. Unscrew the red plastic lamp cover on the front panel over the dynamotor assembly, and remove bayonet-based Lamp LM–52. Remove Lamp LM–52 located behind the front panel between the KEY and MICROPHONE jacks. Remove Lamp LM–52 located behind the front panel to the right of the ANT. CURRENT meter. Both of these lamps are accessible through the opening in the front panel.

e. FUSES. Remove two Fuses FU–12–A and three Fuses FU–43, which are mounted on the panel board in the recess in the upper right-hand side of front panel. Remove the spare fuses mounted on the back of the removed portion of the front panel.

6. Cleaning, Inspection, and Lubrication of Main Chassis

a. CLEANING AND INSPECTION. Use clean, dry, low-pressure compressed air to blow out all dust particles in unit. Use a clean brush to remove dust from corners and other spots difficult to reach. Exercise care when cleaning terminal contact points and switches, jacks, binding posts, etc. Remove corrosion from terminals, pins, and unpainted parts of unit, using a fine grade of sandpaper. *Do not use abrasives on switch contacts or nickel-plated surfaces.* Apply solvent, dry-cleaning with a brush to switch contact points and other parts difficult to reach. Blow out loosened particles with compressed air. Clean gears with a pipe cleaner dipped in dry-cleaning solvent (SD). Inspect wires for broken connections, frayed ends, shorts, and poor insulation. Check resistors, capacitors, chokes, etc., for broken parts, charred spots, and other signs of overload. Inspect terminals to see that they are secure and properly soldered. Check for chipped and broken parts in sockets, plugs, switches, jacks, binding posts, etc. Check for loose, bent, or broken prongs and pins on plugs. Tighten all screws and nuts. Secure mountings of all pointers on PRESET FREQUENCIES IPA TUNING, A, B, C, and D; PRESET FREQUENCIES FREQ. CONTROL, A, B, C, and D; and PRESET FREQUENCIES ANTENNA COUPLING A, B, C, and D. Inspect the operation of the dial locks to see that the dials are held in place when the locks are tightened. Inspect tuning knobs to see that they do not rub against the panel, and that they are securely fastened on the shafts. Check the operation of the TUNING LF-HF knob and the dial lock. See that panel switches snap firmly into place at each contact position. Check spring action of all sliders on coil L143 by moving each slider up one or two turns, releasing, and then moving slider back to its original position and releasing. Each slider must make snug contact with the turns. Check the condition and continuity of the antenna wire from the A binding post to the REC binding post. Check all porcelain and ceramic parts for cracks and chips. Check for leaks in all oil-filled capacitors. Inspect plastic terminal strips, plugs, jacks, and lamp retainers for breaks, cracks, and chipping. Be sure that two gauges are taped to the metal frames of capacitors C129 and C105, or are held to the frame with screws. Tighten the screws. Check to see that three Bristo wrenches are in the p-a tube compartment. Straighten all bent parts of the transmitter frame. Repaint all painted surfaces that are worn or chipped.

b. LUBRICATION. Use lubricants sparingly. The following approved lubricants should be used on Radio Transmitter BC–653–A:

(1) *Special lubricating oil (PS).* Lubricate shafts, thrust washers, positioning devices, and bearings, using only the minimum amount necessary for proper lubrication. Carefully wipe off any excess.

(2) *Special lubricating grease (GL).* Lubricate dial mechanisms and gears, again using only the minimum amount necessary and wiping off any excess.

(3) *General purpose grease No. 2 (WB2).* Used for dynamotor lubrication. (See TB SIG 134.)

7. Cleaning and Inspection of Removed Parts

a. SHIELDS, PATCH PLATES AND RUNNERS. Straighten all bent parts. Remove corrosion with a fine grade of sandpaper. Blow out all loosened particles. Clean surfaces with dry-cleaning solvent (SD) applied with a lintless cloth. Clean and inspect all Dzus fasteners, spring clamps holding Bristo wrenches, fuses, fuse clamps, and other parts for bent or broken elements and for corrosion. Inspect for the presence of Bristo wrenches on the side plate in the p-a compartment. Inspect for spare parts on the fuse panel door, two Fuses FU–12–A in holders, and six links Fuses FU–44 in an envelope fastened to the

back of the panel door by two spring clamps. Examine the air filter on the rear outer shield of the transmitter. Use compressed air to blow out any dirt that has accumulated on the filter. If the filter is too dirty, insert a new one as follows: Remove six screws holding the perforated plate inclosing the filter, remove the old filter, and replace with the new one. Clean and remove corrosion from perforated plates with a fine grade of sandpaper, and blow out loosened particles. Retouch worn painted surfaces. *Take care when handling the spun-glass air filter to prevent small splinters of glass from entering the fingers.* Replace the new filter between the perforated plates, and fasten the assembly to the rear cover plate with six screws. Clean and inspect the runners; straighten those which are bent. Retouch all painted surfaces that are chipped or scraped.

b. TUBES. Clean pins of each tube with dry-cleaning solvent (SD) applied with a brush. For heavier corrosion, use crocus cloth applied with care to nickel-plated surfaces of pins. Inspect tubes for bent pins and for internal and external breaks. Shake the tube to detect loose pins and elements. Check the two Tubes JAN–1613 on a tube checker, allowing sufficient time for the tubes to warm up. Tap the tube gently during the test to detect loose or defective elements.

c. LAMPS. Inspect lamps for broken filaments. Clean contacts with dry-cleaning solvent (SD). Clean the red plastic lamp cover, and inspect it for breaks or cracks.

d. FUSES. Clean fuse contacts and clips with dry-cleaning solvent (SD). Inspect for broken or cracked parts.

e. DYNAMOTOR. For complete information on inspecting, cleaning, lubricating, and repairing dynamotor see TB SIG 134.

8. Replacement of Defective Parts

a. Before replacing any part which, on inspection, indicates improper electrical operation or signs of overload such as charring and burning, make a thorough electrical check of the circuit to discover the cause of improper operation. Check voltages and resistances as outlined in section VIII, and correct the trouble before replacing defective parts.

b. Replace all wires having charred or poor insulation. Resolder all broken or poor connections. Replace all faulty or missing fuses. Replace all defective tubes, lamps, resistors, capacitors, coils, chokes, or other elements. Replace all missing or defective screws, washers, bolts, nuts, runners, or other parts.

SECTION IV

PRELIMINARY TROUBLE-SHOOTING PROCEDURES

Warning: Exercise safety precautions at all times. Operation of this equipment involves the use of high voltage dangerous to life. Repairmen must at all times observe safety regulations. Do not change tubes or make adjustments inside the equipment when the high-voltage supply is on. Do not depend upon front cover plate interlocks.

Do not check, adjust, or operate the equipment with shields removed without the immediate presence or assistance of another person.

9. Resistance Measurements

a. General. Trouble within the transmitter can often be detected by checking typical resistances in the circuit before applying power. Table III gives important resistance check points as an aid in locating trouble. Minor variations from these typical readings are permissible, but should not exceed a tolerance of plus or minus 10 percent. If the readings obtained do not agree with those in table III, refer to section VIII, and correct the fault before proceeding.

b. Preparation and Measurement. It is important that all data be taken under the following conditions:

(1) No external wires attached to pins of plug P161.

(2) Radio Transmitter BC–653–A removed from Mounting FT–253–A, and resting on its right end.

(3) All vacuum tubes, three Lamps LM–52, and all shields removed.

(4) Dynamotor removed.

(5) No plugs inserted into the MICROPHONE or KEY jacks.

(6) Links set for 12-volt operation.

(7) METER SW set at PA PL.

c. Tube Socket Resistance Measurements. Figure 7 shows the top view of the tube socket layout of Radio Transmitter BC–653–A. Important resistance measurements from these sockets are indicated on figure 7.

Table III. Typical circuit resistances

From	To	Resistance in ohms
L180–1	L180–2	110
T181–1	T181–2*	0–15
T181–3	T181–4	2300
T180–1	T180–2	490
T180–3	T180–4†	490
T180–7	T180–5	220
T180–6	T180–5	110
P161–1	J160 (spring)**	13
P161–1	X160–3‡	12.5
L102–1	L102–2	13
L103–1	L103–2	13
L122–1	L122–2	13
L140–1	L140–2	13
L141–1	L141–2	13
L142–1	L142–2	13
L144–1	L144–2	13

*Depends on setting of R190.
†Includes R189.
**For checking K161 and F161.
‡For checking K160 and F160.

10. Replacement of Removed Parts

Plug the dynamotor into the transmitter and fasten it with the four screws. Note the position of the six links at the top right of the transmitter (S164A, B, C, D, E, and F). These links must be firmly locked in the direction corresponding to the 12- or 24-volt markings on the link board, depending upon the power supply in use. Dynamotor DM–42–A is used for 12-volt operation; Dynamotor DM–43–A is used for 24-volt operation. Insert all vacuum tubes in their respective sockets. Connect the three plate caps firmly. Note that the sockets of tubes V120, V140, and V141 are equipped with clamps which secure these larger tubes in place. Tighten these clamps by turning them one-quarter turn toward the right, using the long-bladed screw driver located to the left of tube V120, as viewed from the rear of the transmitter. Replace the three Lamps LM–52. Replace all shields, covers, patch covers, and runners.

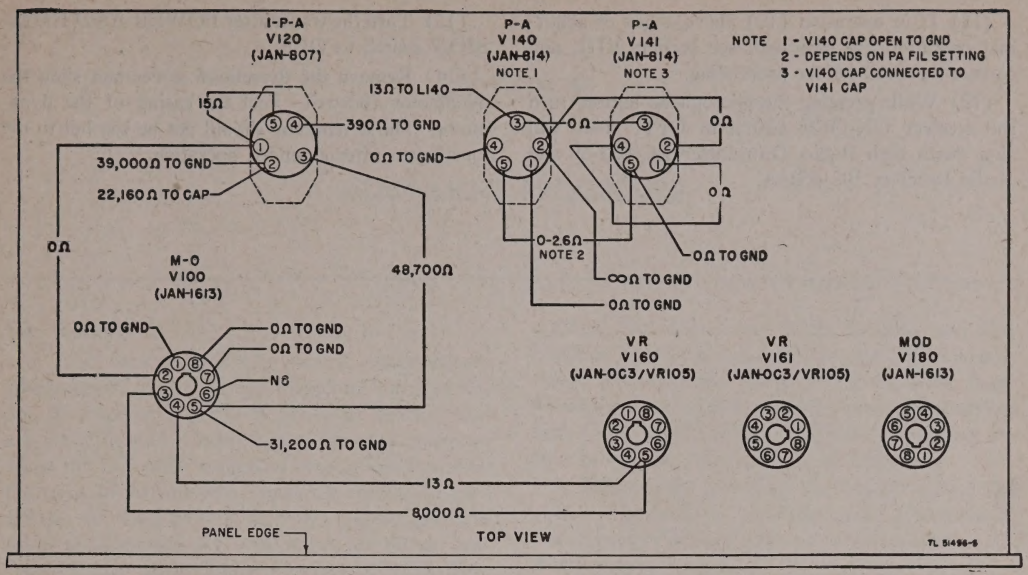


Figure 7. Tube socket resistance measurements, Radio Transmitter BC–653–A.

11. Preliminary Operating Test

Caution: Operation of this equipment involves voltages dangerous to life. Observe all safety regulations at all times. When working on the electrical connections of mounting FT–253–A or on its supply line fuse FU–44, the main battery switch must be off.

a. Assembly on Mounting FT–253–A. Slide Radio Receiver BC–652–A and Radio Transmitter BC–653–A into position on Mounting FT–253–A, and secure them in position with the five wingnuts provided along the lower edge of the front panels. This operation automatically connects the power supply leads and the interconnections to the radio transmitter.

b. Test. (1) Turn on the main battery switch, and turn the receiver ON-OFF switch to ON.

(2) Plug in Headset HS–18, HS–23–A, HS–30–( ), or Loudspeaker LS–3, and rotate the INCREASE OUTPUT control until receiver hiss is heard, indicating that the vacuum tubes have warmed up and are functioning.

(3) Turn the CFC ON-OFF switch to ON.

(4) With the receiver CW-MVC-AVC switch at CW, rotate the TUNING control and listen to the crystal signals. These signals will occur at either 20- or 100-kc intervals, depending upon the position of the INTERVAL switch on the crystal frequency calibrator.

(5) Start Radio Transmitter BC–653–A by turning the POWER AND EMISSION switch to CAL & NET. The dynamotor will start and the red pilot lamp will glow.

(6) Inspect set for any sign of abnormal operation such as smoking, arcing, crackling, burning, etc. If abnormal behavior is noted, turn the set off immediately and see section VIII. Locate and correct the fault before proceeding.

(7) Plug in Key J–45 and close it. The antenna break-in relay within Radio Transmitter BC–653–A will operate, and Radio Receiver BC–652–A will be desensitized each time the key is closed. A 1,000-cycle sidetone will be heard in Headset HS–18, HS–23–A, HS–30–( ), or Loudspeaker LS–3.

(8) If in operation (7) above, signs of abnormal operation are indicated, see section VIII, and correct the fault before proceeding.

(9) Set the METER SW switch to PA FIL, and adjust the PA FIL rheostat until the needle on the FIL & PL CURRENT meter points to the white triangle.

(10) With Key J–45 open, plug in Microphone T–17, T–30–A, or T–45 and turn the POWER AND EMISSION switch to VOICE. The dynamotor will stop running and the red pilot lamp will go out. Press the microphone button. This will start the dynamotor and will thus control Radio Transmitter BC–653–A for voice operation.

(11) If in operation (10) above, signs of abnormal operation are indicated, see section VIII, and correct the fault before proceeding.

(12) While pressing the microphone button, turn the receiver ON-OFF switch to OFF. This will shut down both Radio Transmitter BC–653–A and Radio Receiver BC–652–A.

(13) Turn the transmitter POWER AND EMISSION switch to OFF.

(14) Remove the dynamotor cover and slide the dynamotor forward. Feel the casing of the dynamotor. The dynamotor should not be too hot to the touch even after extended operation.

SECTION V

ALIGNMENT PROCEDURE

12. General

a. The master-oscillator (m-o), intermediate-power-amplifier (i-p-a), and modulator tubes of Radio Transmitter BC–653–A are slow heating, and are wired in such a manner that they are energized when the ON-OFF switch of Radio Receiver BC–652–A is thrown to ON. Since the receiver is usually on for long periods of time, these transmitter tubes are automatically kept warm for instant use.

b. Always allow Radio Receiver BC–652–A to warm up for 10 to 15 minutes before attempting to set Radio Transmitter BC–653–A on an exact frequency.

c. After making final adjustments as described in this section, do not fail to lock the dials.

d. DO NOT OPERATE THE SAFETY INTERLOCKS WITH THE COVERS OFF. These interlocks are provided for the operator's safety.

e. Do not attempt to calibrate Radio Transmitter BC–653–A with the POWER AND EMISSION switch on CW¼, CW FULL, or VOICE. Radio Receiver BC–652–A is desensitized and nonoperative under these conditions with the key down. Calibrate on CAL & NET. If the signal in the receiver is too strong on CAL & NET, remove the short connecting wire from the antenna binding post on the receiver while calibrating, but do not fail to replace the connecting wire when calibration is completed.

13. Preset Frequency Adjustments

a. Preparation. (1) *M-O Coil links.* First, having selected the four frequencies A, B, C and D, remove the cover plate and arrange the eight links according to the engraving on the cover plate. For example, if frequency A is within 2 and 3 mc connect the two A links to the left. If the chosen frequency is between 3 and 4.5 mc, connect the two A links to the right. Note that there are two links for each frequency.

(2) *I-P-A Coil links.* After all four m-o frequencies have been grouped into the correct bands, repeat link-adjusting operation for the i-p-a stage. These links are located under the cover plate marked IPA COILS PRESET FREQUENCIES, and are four in number, one for each frequency.

b. Procedure. (1) Turn the BAND CHANGE switch to position A. This places into service all the circuit components necessary for transmission on the A frequency.

(2) Next, throw the METER SW switch to IPA PL, and turn the POWER AND EMISSION switch to CAL & NET. This procedure starts the dynamotor, turns on the p-a filaments and applies plate power to the m-o and i-p-a tubes, causing these stages to function.

Note. With the POWER AND EMISSION switch at CAL & NET the screen grids of the p-a tubes are given a negative bias which prevents this stage from amplifying. Thus, Radio Receiver BC–652–A will pick up the relatively weak oscillations from the master oscillator, rather than the very strong signal from the power amplifier.

(3) Adjust Radio Receiver BC–652–A for c-w reception at the calibration mark corresponding to the channel or frequency desired. Rotate the PRESET FREQUENCIES FREQ. CONTROL A until zero beat is heard, indicating that the master oscillator is correctly set to the A frequency.

(4) Tune the intermediate power amplifier by adjusting the PRESET FREQUENCIES IPA TUNING control A until resonance with the master oscillator is indicated by a *minimum* FIL & PL CURRENT meter reading.

(5) Repeat the m-o frequency setting and the i-p-a tuning for frequencies B, C, and D, using the corresponding positions of the BAND CHANGE switch for each frequency.

(6) Resonate the power amplifier and antenna, which together act as one circuit. With the BAND CHANGE switch at A, refer to the chart on the back of the PA COIL cover plate for the approximate setting of the p-a coil taps. Set the taps

marked A, B, C, and D to the correct turns, to move the sliders, pull slightly and then slide the knobs.

Caution: Care must be taken to adjust all coil taps exactly on the wires of the coil. Serious loss of operating efficiency, together with overheating of the coil, will result if a tap is allowed to rest between two turns of the coil.

(7) With the POWER AND EMISSION switch at CW¼, replace the PA COIL cover plate. Set the METER SW to PA PL, in order to read the p-a plate current. Close Key J–45. Adjust the A control of the ANTENNA COUPLING group until a definite dip occurs in the meter reading. If no dip is observed, remove the PA COIL cover plate, move the A tap one turn in either direction, and replace the cover. Retune ANTENNA COUPLING control A and look for the current dip. Repeat this procedure until a current dip occurs.

(8) When minimum current has been obtained, take a reading of the ANT CURRENT meter. Radio Transmitter BC–653–A will be emitting a steady c-w signal at CW¼ power. Turn the POWER AND EMISSION switch to CW FULL and note the reading of the FIL & PL CURRENT meter. This reading should be between 4.5 and 5.5. (These readings are based on an exact supply of 12.0 or 24.0 volts. A slightly higher or lower supply voltage will cause a correspondingly higher or lower reading.) If the reading is below 4.5, full power is not being obtained, and more power may be coupled out by removing the PA COIL cover plate and moving the A tap upwards one turn. Move the tap HIGHER to obtain HIGHER output and LOWER to obtain LOWER output.

(9) Repeat this tuning operation for frequencies B, C, and D, making the preliminary tap setting of the p-a coil at CW¼ power, and adjusting the final tap positions at CW FULL power.

(10) Although Radio Transmitter BC–653–A can now be operated on any one of its four preset frequencies, it should be set more accurately to the exact frequency with the crystal frequency calibrator.

(*a*) Open Key J–45. Move the BAND CHANGE switch to position A, and the POWER AND EMISSION switch to CAL & NET. Place the CW-MVC-AVC switch of Radio Receiver BC–652–A at MVC, turn the CFC ON-OFF switch ON, set the INTERVAL switch at 20 kc and set the receiver dial for the A frequency, which must be a multiple of 20, for example: 3,500 kc, 4,220 kc, 4,400 kc, etc.

(*b*) Radio Receiver BC–652–A can now receive both the crystal harmonic and the m-o signal from Radio Transmitter BC–653–A. Adjust the receiver output until a satisfactory beat is audible, and then carefully readjust the A control of the PRESET FREQUENCY FREQ. CONTROL group for zero beat. This places the preset frequency A exactly on the correct channel.

(*c*) Repeat this accurate frequency-setting procedure for frequencies B, C, and D, and lock all preset controls to prevent them from being accidentally moved.

(11) Radio Transmitter BC–653–A is now ready for transmission on any one of its four preset frequencies. Check the operation by holding Key J–45 closed, setting the BAND CHANGE switch successively to A, B, C, and D, and noting the antenna current. This current varies depending upon the frequency and the type of vehicle concerned, but is usually about 3 amperes or more on CW FULL.

(12) No harm will be done to controls of the BAND CHANGE switch when it is turned under full power, and with the key locked, since it is equipped with an interlock which opens the key relay circuit between the switch positions.

14. Tunable Frequency Adjustments

a. GENERAL. This type of operation is designed to provide communication on one additional frequency which may be quickly adjusted over any portion of the complete band. Operating procedure is similar to that outlined in paragraph 13, with the exception of the m-o and i-p-a tuning circuits which are ganged and accurately calibrated in channel numbers.

b. PROCEDURE. (1) First set the BAND CHANGE switch to either LF or HF, depending upon whether the desired channel lies between 0 and 50 or between 50 and 125. With the POWER AND EMISSION switch at CAL & NET, rotate the TUNING LF-HF control to channel 40 or to channel 120, depending upon the band chosen. This number will appear in one of the small windows adjacent to the control. Be sure to read the counter corresponding to the position of the BAND CHANGE switch.

(2) With Radio Receiver BC–652–A set to CW at the chosen transmitter frequency, and the CFC ON-OFF switch set to OFF, listen for the m-o signal. Rotate the MO RESET LF-HF control until zero beat is heard, then set the CW-MVC-AVC switch on the receiver to MVC, the CFC ON-OFF switch to ON, and the INTERVAL switch to 100 kc. If

necessary, readjust the MO RESET LF-HF control slightly for zero beat. Lock this control. During operation, this control is generally set near the middle of its scale.

(3) The master oscillator is now set exactly on the chosen channel. To operate on any other channel in the selected band, rotate the TUNING LF-HF control until the desired channel number appears, taking care to read the counter corresponding to the position of the BAND CHANGE switch. This operation automatically tunes the intermediate power amplifier along with the master oscillator, since their tuning capacitors are ganged.

(4) Turn the POWER AND EMISSION switch to CW, and the METER SW switch to PA PL. Remove the PA COIL cover plate and set the central T slider to the correct setting, by referring to the chart provided for this purpose. Replace the cover, press Key J–45, and tune the control marked ANT COUP'G LF-HF for minimum reading in p-a plat current. Proceed, as in the case of the preset frequencies, to adjust the p-a coil tap and the ANT COUP'G LF-HF control until the p-a plate current is between 4.5 and 5.5 on CW FULL. Lock all controls to prevent accidental movement.

(5) It will be noted that one of the two positions, LF and HF, of the BAND CHANGE switch is always unused. Since the p-a and antenna circuits are out of tune on this unused position, it is important that no operation be attempted here. While momentary operation will cause no harm, a prolonged key-locked condition may damage the p-a tubes.

(6) Once the MO RESET LF-HF control has been adjusted for either the LF or the HF band, it need not be touched for any of the channels of that band, unless a change is made which alters the stray capacitance of the m-o circuit. Such changes include replacing the m-o tube, shifting any of the coil links, or turning the BAND CHANGE switch from LF to HF or from HF to LF. In such cases, the tunable band in use may be kept on calibration by tuning to channel 40 or 120, and adjusting the MO RESET LF-HF control to zero beat with a harmonic of a 100-kc signal.

15. Master-Oscillator Alignment

a. General. The stage schematic diagram, figure 15, shows the components of the tunable m-o circuit. Capacitor C105 is adjusted during manufacture to maintain a straight-line frequency characteristic when used with the correct paralleled capacitor and the correct value of inductance in coils L100 and L101. During normal operation, no adjustments in this circuit are required except by panel controls. In case of damage to the circuit components, resulting in large calibration errors of the m-o tuning dials, the following procedure for realignment is recommended.

b. Procedure. (1) With the BAND CHANGE switch at LF, turn the POWER AND EMISSION switch to CAL & NET, and rotate the TUNING LF-HF control to channel 10 which is 2.2 mc.

(2) Using Radio Receiver BC–652–A in conjunction with its crystal frequency calibrator, set the CW-MVC-switch at AVC, listen on AVC for the signal of the master oscillator, and adjust it exactly to zero beat with the MO RESET LF-HF control.

Note. If the MO RESET LF-HF control has to be turned more than approximately 20 divisions from the center of its scale, its range of operation may be brought back to center by means of padding capacitor C106. Capacitor C106 is set during manufacturer and should need no further adjustment, unless the components of the m-o circuit have become seriously disarranged or damaged.

(3) Rotate the TUNING LF-HF control and the receiver TUNING control to channel 40, and listen for the m-o signal as before. If the oscillator is covering the LF range correctly, channel 40 will be on zero beat with the 2.8-mc harmonic of the crystal. If zero beat is obtainable by moving the channel indicator dial approximately ⅛ inch, calibration is sufficiently accurate, and no further alignment should be attempted.

(4) If, however, the error is in excess of this, coil L100 must be adjusted. Remove all votage from Radio Set SCR–506–A and withdraw Radio Transmitter BC–653–A from Mounting FT–253–A. Remove the bottom shield and the inner shield which covers coils L100 and L101. This inner shield is located nearest the center towards the front.

(5) The head of the adjusting screw located in the end of coil L100 moves a copper slug within the coil, and thus changes the inductance of the m-o circuit. Clockwise rotation of the screws withdraws the slug and thus increases the inductance; counter-clockwise rotation inserts the slug, and thus decreases inductance. If the channel 40 zero beat is heard somewhat above the 40 mark (about 40 plus ¼ inch, for example), the inductance must be increased.

(6) If the channel zero beat occurs when the channel indicating line is above the fixed reference line, the inductance must be increased. In this case, rotate the adjusting screws of coil L100 one full turn clockwise. If, however, the channel indicating line falls below the fixed reference line at zero beat,

the adjusting screw of L100 must be rotated one full turn counterclockwise.

(7) Rotate the adjusting screw of coil L100 a full turn in the direction determined by the above rule, replace the inner and outer bottom shields using only four screws each, and slide Radio Transmitter BC–653–A back on Mounting FT–253–A.

(8) Repeat steps (1) and (2) above, as the MO RESET LF-HF control must be readjusted to make up for the change in L100.

(9) Repeat step (3) above and note the new error at channel 40. If it is still in excess of about 1/8 inch, repeat steps (4) and (5) until the error has been reduced to within the allowable limits. The last few trials should be made with smaller and smaller variations in the rotation of the adjusting screw, allowing for some lost motion.

(10) Check the high-frequency (h-f) band in the same manner as given in the above nine steps, except that the BAND CHANGE switch must be set at HF, coil L101 must be adjusted, and channels 55 and 120 are used in place of channels 10 and 40.

(11) Replace all shields, and give the MO-RESET LF-HF control a final adjustment.

(12) If the m-o or i-p-a compartments have been damaged, capacitors C105 and C129 must be re-aligned as follows:

(*a*) Place Radio Transmitter BC–653–A on its right end and remove all m-o and i-p-a shields.

(*b*) Turn BAND CHANGE switch to PRESET FREQUENCY A.

(*c*) From the corner bar of each capacitor (C105 and C129) remove the small spacing gauge which is either taped or screwed into place. Take care not to interchange these gauges, either with each other or with those of another equipment.

(*d*) Insert each spacing gauge in its respective capacitor in such a manner that when the TUNING LF-HF control is rotated clockwise, the gauge prevents the rotor from reentering the stator. Thus the rotor and stator plate edges are separated by approximately 1/16 to 1/8 inch of space, depending upon the capacitor.

(*e*) If alignment is correct, each rotor will touch its respective gauge at the same time that channel 130.5 (a half channel is designated by a red dot between the regular channel lines) is indicated on the HF channel counter. The exact time of gauge contact can be accurately found by using an ohmmeter across the capacitor being adjusted.

(*f*) If alignment is not correct, first bring capacitors C105 and C129 into line, using the gauges and the adjusting yoke. This yoke is controlled by two setscrews, and permits angular adjustment. It is located on the insulating coupling ring which mounts on the large brass gear between capacitors C105 and C129. Next the HF CHANNEL counter may be brought into step (at 130.5) by means of either of the two couplings just behind th channel counter gears.

(*g*) Recheck as in (*e*) above.

16. Intermediate-Power-Amplifier Alignment

a. General. After the m-o circuits are aligned, it is necessary to align the intermediate power amplifier so that the two stages will track correctly. After alignment, the intermediate power amplifier will always be in tune with the master oscillator, when the BAND CHANGE switch is at either LF or HF.

b. Procedure. (1) As a quick check on i-p-a alignment, place the POWER AND EMISSION switch at CAL & NET, set the MO RESET LF-HF control as outlined in paragraph 14, and rotate the TUNING LF-HF control over the entire HF band from channel 50 to channel 125, noting the reading of the i-p-a plate current. If this reading is essentially constant and below the 4.0 mark, the intermediate power amplifier is aligned on the HF band.

(2) If the meter reading varies enough to appreciably exceed 4.0, remove Radio Transmitter BC–653–A from Mounting FT–253–A, and apply power applied, as outlined in paragraphs 18*b* and 18*c*. With the POWER AND EMISSION switch at CAL & NET, note the i-p-a plate current at channel 80. Remove all power, and adjust the i-p-a trimmer capacitor C126 about one-eighth of a turn in either direction. If capacitor C126 is of the two-plate type, set it for maximum capacitance and adjust the slug screw of coil L121 for minimum i-p-a plate current at channel 80, and disregard (3), (4), and (5) below. Replace the top shield temporarily with several screws, apply power and again note the i-p-a plate current.

(3) Repeat this operation until the i-p-a plate current, at channel 80, is at *minimum*, showing perfect i-p-a tuning at this channel.

(4) While observing the i-p-a plate current reading, rotate the TUNING LF-HF control towards the higher channel numbers. If this reading remains essentially constant and below 4.0, no further adjustment is required on this band. Should the meter reading increase towards the higher channel numbers, stop rotating the TUNING LF-HF control, remove power, and readjust capacitor C126 by the

method outlined in (2) and (3) above, until a minimum i-p-a plate current is again indicated. Remember in which direction capacitor C126 was rotated. The fact that the trimmer position had to be altered indicates that the i-p-a tank coil L121 was not correctly adjusted. A copper slug within this coil serves to vary its inductance slightly when the end screw is rotated. Figure 6 shows h-f i-p-a coil L121.

(5) If capacitor C126 was increased, coil L121 must be decreased by rotating its slug-adjusting screw counterclockwise. If capacitor C126 was decreased, coil L121 must be increased. Observing these rules, turn the adjusting screw two or three complete turns, adjust C126 at channel 80 as before and again rotate the TUNING LF-HF control towards the higher channel numbers. Repeat the adjustment of coil L121 and capacitor C126 until the i-p-a plate current is essentially constant over channels 50 to 125.

(6) The i-p-a stage is now in track with the master oscillator on the HF band. The LF band is broadly tuned by means of a nonadjustable slug within coil L120, and will require no adjustment. A final check over the two bands should result in a practically constant i-p-a plate current of less than 4.0.

(7) If the above alignment procedure was done as a result of serious damage to the i-p-a or m-o compartments, make a final check of the m-o alignment after completing the i-p-a alignment.

(8) Replace all shields in a permanent manner, and slide Radio Transmitter BC–653–A back on Mounting FT–253–A.

17. Power-Amplifier Bias Adjustment

a. General. Rheostat R177 provides a variable bias voltage for the grids of the p-a tubes when the POWER AND EMISSION switch is at VOICE. Ordinarily this rheostat is set during manufacture and needs no further adjustment. If, however, its setting has been changd, the following procedure for resetting is recommended.

b. Procedure. (1) Tune Radio Transmitter BC–653–A, set to CW FULL, to any convenient frequency. Make certain it is properly loaded by Phantom Antenna A–27–( ). Note reading of ANT CURRENT meter.

(2) Rotate the POWER AND EMISSION switch to VOICE, and press the microphone handle control switch. Note reading of ANT CURRENT meter. It should be approximately one-half of the CW FULL reading. If it is not, adjust rheostat R177 until it is. This relation of VOICE current to CW FULL current may not hold exactly over all conditions of frequency and antenna tuning, but no harm will result from this.

(3) Potentiometer R190 is preadjusted to permit correct modulation percentage during VOICE operation. This control is set for approximately 90 percent peaks during loud voice passages, and can be properly adjusted only by viewing the modulated output on a cathode-ray oscilloscope.

SECTION VI

DETAILED TROUBLE-SHOOTING PROCEDURES

18. Typical Circuit Voltages

a. All circuit voltages of Radio Transmitter BC–653–A are measured with a voltmeter of 1,000-ohm-per-volt sensitivity. These voltages are all direct-current (d-c), and in each case the meter scale used is the lowest one applicable. All measurements are to be made with the negative terminal of the meter grounded, unless otherwise specified.

b. Remove Radio Transmitter BC–653–A from Mounting FT–253–A, withdraw the dynamotor and take off all the shields. Stand the radio transmitter on its right end for maximum accessibility to the circuits to be checked. Be certain that all vacuum tubes are in place and that all safety interlocks are firmly closed. Plug in Key J–45 and Microphone T–17, T–30–A, or T–45. Close the key.

c. The positive and negative terminals of a 12-volt d-c supply should be connected to terminals 10 and 11 respectively, of plug P161. No. 16 wire will suffice for these connections, as no heavy currents are drawn during these tests. Terminals 1 and 10 of the same group must be connected to simulate the action of the ON-OFF switch of Radio Receiver BC–652–A.

Caution: Do not select the wrong pins of plug P161; do not short adjacent pins.

d. During 24-volt operation all voltages remain the same, except those listed as 12 volts in the first three columns. These voltages then change to 24 volts.

Table IV. Filament and control voltages

Power and emission switch	P161–1	F161*	F160*	X120–1†	X120–5	X140–5	L180–2
Off	12	12	0	5.6	12	0	0
Cal & Net	12	12	12	5.6	12	10	10
CW¼	12	12	12	5.6	12	10	10
CW Full	12	12	12	5.6	12	10	10
Voice**	12	12	0	5.6	12	0	0
Voice‡	12	12	12	5.6	12	10	4

*Both ends of the fuse.

†Socket X120, pin No. 1. Refer to tube socket diagram figure 7, and to connection diagram figures 25 and 26.

**Microphone T–17 or T–30–A plugged in; handle control or Switch SW–141–W open.

‡Microphone T–17 or T–30–A plugged in; handle control or Switch SW–141–W closed.

e. In all positions of the POWER AND EMISSION switch, break-in relay K161 will be actuated whenever Key J–45 is operated. With the key locked, rotate the BAND CHANGE switch. The break-in relay should click in and out for each position of this switch, indicating that switch interlock S165 is functioning.

f. With the POWER AND EMISSION switch at VOICE, dynamotor relay K160 will be energized when Key J–45, the press-to-talk switch on Microphone T–17, or Switch SW–141–W for Microphone T–30–A is depressed. Since the dynamotor has been removed for these tests, the only results will be the lighting up of the p-a filaments and the red indicator Lamp LM–52. Removal of the i-p-a coil link cover plate, the PA COIL cover plate, the fuse cover plate, or either of the voltage regulator tubes V160 or V161, will open the dynamotor-relay circuit. This is a protective measure incorporated in Radio Transmitter BC–653–A to prevent its accidental operation when the above mentioned cover plates or voltage regulator tubes are removed. Without this protective measure the operator would be exposd to high voltages, or dangerously high voltages would be imposed on the elements of the m-o tube.

g. Slide the dynamotor into place. Remove the upper Fuse FU–12–A, replace the fuse cover plate, and close Key J–45. Using well-insulated wires and test clips, make the checks indicated in table V.

Warning: The following checks involve the use of high voltages which are dangerous to life. Operating personnel must at all times observe all safety regulations. Ground the frame before making any checks. Turn the power and emission switch to off while making connections.

19. Typical Circuit Resistances

If the check of the typical circuit voltages made in the preceding paragraph does not locate trouble, the

resistance measurements of paragraph 9 and table III of section IV should be repeated.

20. Master Oscillator

a. Test and Indication. Set the transmitter POWER AND EMISSION switch to CAL & NET. Set the BAND CHANGE switch to PRESET FREQUENCY A. With a 0.001-microfarad (mf) capacitor in series with the high side of a radio-frequency (r-f) vacuum-tube voltmeter, check for r-f voltage from stator to rotor of capacitor C101. Place the free end of the 0.001-mf capacitor in contact with the stator, and the other lead of the vacuum-tube voltmeter in contact with the rotor. An r-f voltage should be indicated. Set the BAND CHANGE switch to PRESET FREQUENCIES B, C, and D, and check for r-f voltage across capacitors C102, C103, and C104, respectively. Set the BAND CHANGE switch at TUNABLE HF or LF, depending on the setting of the m-o coil links, and check for r-f voltage across C105.

Table V. Plate and screen voltages

Power and emission switch	F163 Left	F164	L102	L120	V120–2	L142	T180–1	T180–3
Off	0	0	0	0	0	0	0	0
Cal & Net	1,090	480	213	325	155	=46	0	=30
CW¼	1,010	510	214	340	155	30	0	0
CW Full	1,096	500	214	335	150	220	0	0
Voice*	1,060	445	213	310	135	150	300	−60

*Microphone T–17 or T–30–A plugged in; press-to-talk switch or Switch SW–141–W closed. Key J–45 open.

b. Localization. If r-f voltage is not indicated at every switch position, refer to the information covering the stage under test in section VIII. Trace the trouble to the defective part or parts by resistance and voltage checks, referring also to paragraphs 18 and 19.

21. Intermediate Power Amplifier

a. Test and Indication. Set the METER SW to IPA PL, and the BAND CHANGE switch to PRESET FREQUENCY A. Tune the intermediate power amplifier to resonance at the frequency of the master oscillator, as indicated by a *minimum* FIL & PL CURRENT meter reading. Check for this minimum on the other three preset frequencies and on the variable tuning channel.

b. Localization. If minimum reading is not obtained on every band, check link settings of IPA COILS PRESET FREQUENCIES. If these are correct, refer to the information covering the stage under test in section VIII. Trace the trouble to the defective part or parts by resistance and voltage checks, referring also to paragraphs 18 and 19.

22. Power Amplifier

a. Test and Indication. Set the POWER AND EMISSION switch to CW¼ and the BAND CHANGE switch to PRESET FREQUENCY A. With a ¼-watt neon lamp taped to the end of a wooden dowel, probe near the p-a plate coil L143. Tune coil L143 with capacitor C141 for maximum brightness of the neon lamp. Repeat this on PRESET FREQUENCIES B, C, and D, and on the variable tuning channel.

b. Localization. If the neon lamp fails to light on every setting of the BAND CHANGE switch, refer to the information covering the stage under test in section VIII. Trace the trouble to the defective part or parts by resistance and voltage checks, referring also to paragraphs 18 and 19.

23. Modulator

a. Test and Indication. Fasten Radio Receiver BC–652–A and Radio Transmitter BC–653–A on Mounting FT–253–A. Plug Microphone T–17 into the microphone jack of the transmitter. Plug Headset HS–18, HS–23–A, or HS–30 ( ), or Loudspeaker LS–3 into the receiver. Set the POWER AND EMISSION switch at CAL & NET. Press the microphone button and speak into the microphone. Voice sidetone should be heard in the headset or loudspeaker.

b. Localization. If no voice sidetone is heard, the modulator stage is defective. Refer to the information covering this stage in section VIII. Trace the trouble to the defective part or parts by resistance and voltage checks. (See also pars. 18 and 19.)

24. Moistureproofing, Fungiproofing, and Refinishing

After repairs have been completed on Radio Transmitter BC–653–A, check the date of last moistureproofing and fungiproofing. If a new treatment is required, refer to TB SIG 13 for method of application. If the front panel or any covers have been scarred or chipped, remove any rough spots with fine sandpaper and apply paint to spots with a small brush. If the covers are sufficiently scarred or scratched to warrant complete refinishing, remove the covers from the case and prepare their surfaces using fine sandpaper to smooth rough spots and dry-cleaning (SD) to remove dirt and rust. The covers can be hung up by their screw-mounting holes, and sprayed with the proper paint authorized by existing regulations.

SECTION VII

FINAL TESTING

Warning: Exercise safety precautions at all times. Operation of this equipment involves the use of high voltages dangerous to life. Repairmen must at all times observe safety regulations. Do not change tubes or make adjustments inside the equipment when the high voltage supply is on. Do not depend upon front cover-plate interlocks. When performing the final check of equipment, ground every part before touching it.

Do not check or adjust equipment alone. Do not operate the equipment with shields removed without the immediate presence or assistance of another person capable of rendering aid. Exercise safety precautions at all times.

25. Alignment Check

Although the transmitter was correctly aligned during the repair procedure, a recheck of the alignment is necessary after moistureproofing and fungiproofing have been completed. Check alignment as given in section V.

26. Over-all Performance Tests

a. Tests. After the alignment has been checked, the following performance tests are to be made:

Dial calibration.
Backlash.
Voice operation.
Power outpupt.

b. Preliminary Procedure. (1) Connect the ground strap to the transmitter frame under any conveniently placed screw.

(2) Connect the antenna lead from Dummy Antenna A–27–( ) to transmitter binding post A.

(3) Connect 0-5 r-f ammeter in series with the ground side of the dummy antenna. Fasten the ground lead from the r-f ammeter under any conveniently placed screw in transmitter frame.

(4) Connect power source to Mounting FT–253–A.

(5) Adjust input voltage to 12 volts.

27. Dial Calibration Test

a. HF Dial Calibration (MO RESET LF-HF). (1) Check the AB and CD preset link boards to see that links AB are on LF, and CD on HF. The diagram on the compartment door shows the correct positions of the links for the h-f and l-f bands.

(2) Set the IPA COILS PRESET FREQUENCIES cover in place on the panel.

(3) Set the MO COILS PRESET FREQUENCIES cover in place on the panel. (The m-o coil links A, B, C, and D must be in the same relative positions as i-p-a and links A, B, C, and D.)

(4) Place the PA COIL cover plate in position over the p-a coil.

(5) Place the fuse cover in position.

(6) Turn on the external power source.

(7) Turn the transmitter POWER AND EMISSION switch to CAL & NET.

(8) Permit set to warm up for 3 or 4 minutes before proceeding with the next step.

(9) Set the transmitter BAND CHANGE switch to HF.

(10) Set the transmitter METER SW to IPA PL.

(11) Set the CW-MVC-AVC switch of test Receiver BC–652–A at MVC, turn the CFC ON-OFF switch to ON, set the INTERVAL switch at 100 kc and set the receiver dial at 4,400 kc.

(12) Adjust the transmitter TUNING LF-HF dial to channel 120 on the HF side.

(13) Adjust the output of the test receiver until a satisfactory beat is audible, and tune MO RESET LF-HF dial for zero beat. When zero beat is obtained, record the indication of MO RESET LF-HF dial on the calibration curve sheet (fig. 8) at MO RESET HF-CD.

b. HF Dial Calibration (Calibration Curve). (1) Set test Receiver BC–652–A at 3,000 kc. Keep all other settings on the receiver the same as in *a* (11) above.

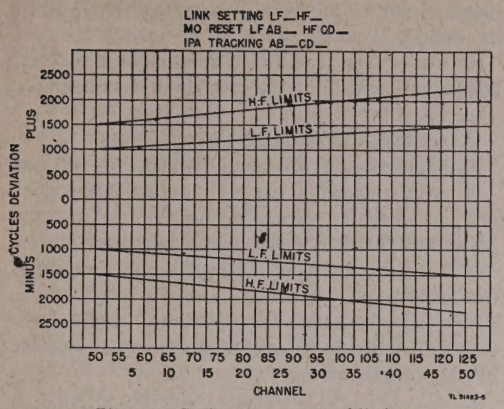


Figure 8. Calibration curves and limits, Radio Transmitter BC–653–A.

(2) Plug the headphones into the PHONE jack on the test receiver.

(3) Set the transmitter TUNING LF-HF dial below channel 50 on the HF side.

(4) Listen for a signal in the headphones.

(5) Bring the tunable dial into channel 50, so that the white lines come exactly together. If the pitch of the signal in the headphones is still going down when the white lines meet, the signal is negative; if zero beat occurs and the pitch of the signal is going up when the white lines meet, the signal is positive.

(6) Remove the headphone plug from the PHONE jack on the test receiver, and insert Plug PL–55 (with twisted leads and bared ends). Connect the bared ends of these leads to the vertical amplifier terminals of a cathode-ray oscillograph. See figure 9 for connections.

(7) Connect an audio oscillator to the horizontal amplifier terminals of the cathode-ray oscillograph. Set the oscillograph to external sweep. Refer to figure 9 for connections.

(8) Set the tunable dial of the transmitter exactly at channel 50.

(9) Vary the frequency of the audio oscillator until a stationary one-to-one Lissajous figure is seen on the screen of the oscillograph.

(10) Plot the reading of the audio oscillator dial obtained in (9) above on the calibration curve sheet (fig. 8) on the vertical line marked 50. Plot this reading with the sign obtained in (5) above.

(11) Repeat (1) through (10) above with the transmitter TUNING HF-LF dial set to each fifth channel in turn from 50 to 125, and with the test receiver tuned to each 100 kc point in turn from 3,000 kc to 4,500 kc.

(12) Connect the plotted points and label the curve HF-CD. The completed curve must fall between the upper and lower HF-CD lines on the calibration curve sheet. (See fig. 8.) At channel 120, the curve must pass through 0 cycles per second (cps).

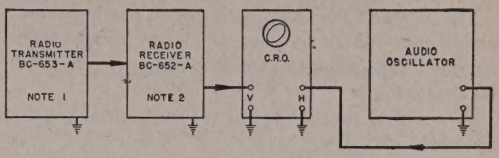


Figure 9. Frequency-checking hook-up, Radio Transmitter BC–653–A.

c. I-P-A Tracking, HF Side. (1) Rotate the transmitter TUNING LF-HF control across the entire HF band from channel 125 to channel 50.

(2) While rotating the control, note the maximum indication on the transmitter FIL & PL CURRENT meter, and record it on the calibration curve sheet (fig. 8) at IPA TRACKING CD.

d. LF Dial Calibration (MO RESET LF-AB). (1) Set the transmitter BAND CHANGE switch to LF.

(2) Rotate the transmitter TUNING LF-HF control to channel 40.

(3) Set the CW-MVC-AVC switch of test Receiver BC–652–A at MVC, turn the CFC ON-OFF switch to ON, set the INTERVAL switch to 100 kc, and set the receiver dial to 2,800 kc. Plug in the headphones.

(4) Adjust the output of the test receiver until a satisfactory beat is audible, and tune the MO RESET LF-HF dial on the transmitter until zero beat is heard in the headphones. Record the indication of the MO RESET LF-HF dial on the calibration curve sheet (fig. 8) at MO RESET LF-AB.

e. LF Dial Calibration (Calibration Curve). (1) Set test Receiver BC–652–A at 2,000 kc, keeping all other settings as before.

(2) Rotate the transmitter TUNING LF-HF control below channel 0.

(3) Listen for the signal in the headphones.

(4) Bring the tunable dial into channel 0 so that the white lines come exactly together. If the pitch of the signal is still going down as the white lines meet, the signal is negative; if zero beat occurs and the pitch of the signal is going up as the white lines meet, the signal is positive.

(5) Remove the headphone plug from the

PHONE jack on the test receiver, and insert test Plug PL–55 (with twisted leads and bared ends). Connect the bared ends of these leads to the vertical amplifier terminals of the cathode-ray oscillograph. See figure 9 for connections.

(6) Connect the audio oscillator to the horizontal amplifier terminals of the cathode-ray oscillograph. Set the oscillograph to external sweep. See figure 9 for connections.

(7) Set the tunable dial of the transmitter exactly at channel 0.

(8) Vary the frequency of the audio oscillator until a stationary one-to-one Lissajous figure is seen on the screen of the oscillograph.

(9) Plot the reading of the audio oscillator dial obtained in (8) above on the calibration curve sheet (fig. 8) on the vertical line marked 0. Plot this reading with the sign obtained in (4) above.

(10) Repeat (1) through (5) above with the TUNING LF-HF dial set to each fifth channel in turn from 0 to 50, and with test Receiver BC–652–A tuned to each 100 kc point from 2,000 kc to 3,000 kc in turn.

(11) Connect the plotted points and label the curve LF-AB. The completed curve must fall between the upper and lower LF-AB lines on the calibration curve sheet. (See fig. 8.) At channel 40, the curve must pass through 0 cps.

f. I-P-A Tracking, LF Side. (1) Rotate *the* transmitter TUNING LF-HF control from channel 50 to channel 0.

(2) While turning the control, note the maximum indication of the transmitter FIL & PL CURRENT meter. Record the maximum indication on the calibration curve sheet (fig. 8) at IPA TRACKING AB.

28. Backlash Test

a. Set the BAND CHANGE switch on the transmitter to HF.

b. Set the CW-MVC-AVC switch of test Receiver BC–652–A at MVC, set the INTERVAL switch to 100 kc, and set the receiver dial to 3,600 kc.

c. Rotate the TUNING LF-HF control until its lower stop is reached.

d. Turn the control back up the scale to exactly channel 80.

Note. If the dial is moved beyond channel 80 and then brought back to the line, the test is inaccurate and a new start must be made.

e. Place test Plug PL–55 in the PHONE jack of the test receiver. Connect the bared ends of the twisted leads to the vertical amplifier terminals of the cathode-ray oscillograph. (See fig. 9.)

f. Connect the audio oscillator to the horizontal amplifier terminals of the cathode-ray oscillograph. (See fig. 9.)

g. Set the oscillograph to external sweep.

h. Set the dial of the audio oscillator to 500 cps.

i. After channel 80 has been located as described in *c* and *d* above, detune the transmitter with the MO RESET LF-HF dial until a stationary one-to-one Lissajous figure is observed on the screen of the oscillograph.

j. Rotate the tuning LF-HF control to the upper stop and return to channel 80 as closely as possible to the previous setting.

Note. As before, if the dial goes beyond channel 80 and has to be returned to its setting, the test is inaccurate and a new start must be made.

k. Vary the setting of the audio oscillator until a stationary one-to-one pattern is again observed on the oscillograph screen. The reading of the audio oscillator dial must now be within 200 and 800 cps.

29. Voice Operation Tests

a. Percent Modulation. (1) Connect an audio oscillator with an output impedance of about 250 ohms; a 25mf, 25 vdcw electrolytic capacitor; an a-c vacuum-tube voltmeter; and Plug PL–68, wired as shown, into the phantom microphone circuit. (See fig. 10.)

(2) Turn on the audio oscillator and the a-c vacuum-tube voltmeter, and set the oscillator output at 1.5 volts 400 cps. *Do not insert Plug PL–68 into the microphone jack of the transmitter until ready to make the test,* as this will throw the transmitter on automatically.

(3) Connect the HI side of the audio oscillator output terminals to the external synchronizing terminal of a cathode-ray oscillograph, as shown in figure 11.

(4) Connect dummy Antenna A–27–( ), with a 0-5 r-f ammeter in series with its ground terminal, to the antenna binding post of the transmitter. Ground the low terminal of the r-f ammeter. (See fig. 11.)

(5) Connect a pick-up loop of a few turns of wire directly to the vertical plates of the oscillograph. *Do not connect to the vertical amplifier terminals.* Loosely couple the pick-up loop to the transmitter output. (See fig. 11.)

(6) Set the POWER AND EMISSION switch on the transmitter to VOICE.

(7) Remove the PA COIL cover plate on the

transmitter, set slider T to turn No. 10 on the coil, and replace the cover.

(8) Set the BAND CHANGE switch to HF.

(9) Rotate the transmitter TUNING LF-HF control to channel 100.

(10) Insert Plug PL–68 of the phantom microphone circuit (fig. 10) into the microphone jack of the transmitter.

(11) Turn the ANTENNA COUP'G LF-HF dial until maximum indication is obtained on dummy antenna meter. This must be at least 1.5 amperes.

(12) Observe the pattern on the cathode-ray oscillograph. Adjust the sweep frequency and the synchronizing voltage gain control until a stable modulation pattern is obtained. This pattern should indicate 90 percent modulation. (See fig. 12.)

(13) If the pattern is not 90 percent modulated, remove the fuse cover, adjust potentiometer R190, replace the fuse cover, and observe the pattern again. Repeat this procedure until 90 percent modulation is obtained. (See fig. 12.)

Note. Removal of the fuse cover shuts off the transmitter. Do not hold down the safety interlock switch while adjusting resistor R190.

(14) Remove Plug PL–68 from the microphone jack.

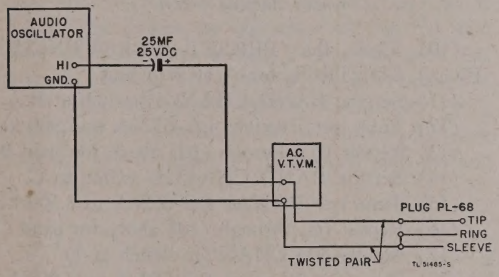


Figure 10. Phantom microphone circuit for modulation, Radio Transmitter BC–653–A.

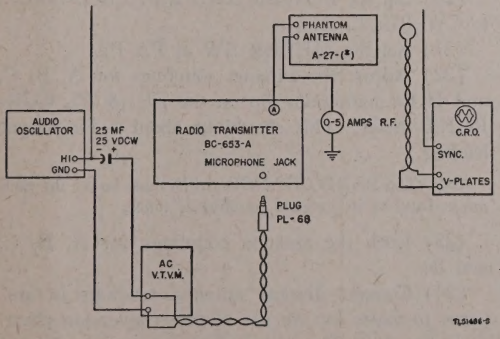


Figure 11. Modulation-checking hookup, Radio Transmitter BC–653–A.

Figure 12. Modulation patterns, Radio Transmitter BC–653–A.

b. VOICE SIDETONE. (1) Using the phantom microphone circuit of figure 10, make the hook-up shown in figure 13, but do not insert Plug PL–68 into the microphone jack of the transmitter until ready to proceed with the test.

(2) Set the audio oscillator output to 1.5 volts at 400 cps, as indicated by the a-c vacuum-tube voltmeter.

(3) Set the a-c rectifier meter to its 50-volt scale.

(4) Set transmitter POWER AND EMISSION switch to VOICE.

(5) Insert Plug PL–68 of the phantom microphone circuit into the MICROPHONE jack of the transmitter.

(6) The a-c rectifier meter should indicate at least 5 volts.

(7) Remove Plug PL–68 from the microphone jack of the transmitter.

(8) Remove Plug PL–55 from the PHONE jack of the receiver, and insert it into the SPEAKER jack.

(9) Insert Plug PL–68 of the phantom microphone circuit into the transmitter microphone jack.

(10) The a-c meter should read 35 volts.

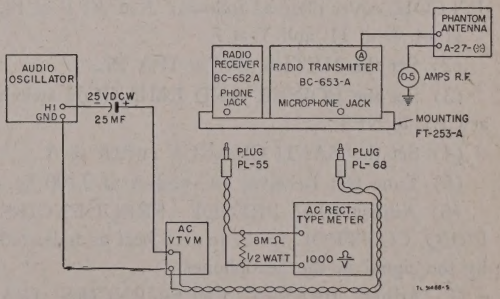


Figure 13. Sidetone-checking hookup, Radio Transmitter BC–653–A.

30. Power Output

a. TUNABLE FREQUENCIES. (1) Rotate the tuning LF-HF control to channel 50, and set tunable dial on panel 50 and BAND CHANGE switch to HF.

(2) Set slider T, under the PA COIL coverplate, to turn No. 18.

(3) Set the POWER AND EMISSION switch at CW FULL.

(4) Adjust the ANT COUP'G LF-HF for maximum current reading on the dummy antenna meter.

Note. For proper loading of the p-a circuit, throw the METER SW to the PA PL position. The FIL & PL CURRENT meter should read about 5 when the antenna coupling is adjusted to maximum dip on the FIL & PL CURRENT meter. Try different turns on the p-a tank coil until proper loading of the p-a circuit is obtained.

(5) Convert the dummy antenna current from amperes to watts. The resistance of dummy Antenna A–27–( ) is 10 ohms. The power output in watts may be obtained by multiplying the square of the current in the 0-5 r-f ammeter by 10. The necessity for calculating this is eliminated by the use of the current-power conversion chart. (See fig. 14.)

(6) Power readings are to be taken at the channels given in table VI, and the power output for each channel should be approximately as given in this table.

Table VI

Channel	Frequency (mc)	Power output (watts)
0	2.0	47
25	2.5	58
50	3.0	66
75	3.5	71
100	4.0	80
125	4.5	80

b. PRESET FREQUENCIES. (1) Set taps under the PA COIL cover plate as follows: A at 30, B at 19, C at 14, D at 11, and T at 7.

(2) Set the METER SW at IPA PL.

(3) Set the POWER AND EMISSION switch at CAL & NET.

(4) Set the BAND CHANGE switch at A.

(5) Tune test Receiver BC–652–A to 2,100 kc.

(6) Adjust the PRESET FREQUENCIES FREQ. CONTROL for A to zero beat as indicated by the signal in the headphones.

(7) Adjust PRESET FREQUENCIES IPA TUNING control for A to maximum dip on the FIL & PL CURRENT meter.

(8) Lock the PRESET FREQUENCIES IPA TUNING control for A.

(9) Readjust the PRESET FREQUENCIES FREQ. CONTROL for A to zero beat again.

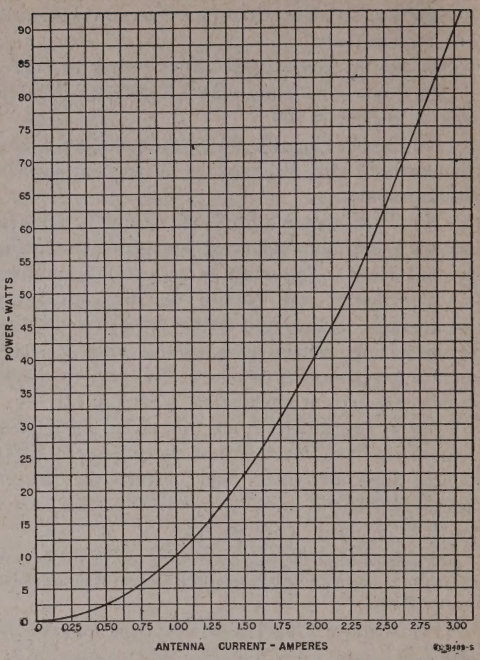


Figure 14. Current-power conversion chart for 10-ohm dummy Antenna A–27–( ).

(10) Lock the PRESET FREQUENCIES FREQ. CONTROL for A at zero beat.

(11) Set the BAND CHANGE switch at B.

(12) Tune test Receiver BC–652–A to 2,900 kc.

(13) Repeat (6) through (10) above for band B.

(14) Set the BAND CHANGE switch to C.

(15) Tune test Receiver BC–652–A to 3,500 kc.

(16) Repeat (6) through (10) above for band C.

(17) Set BAND CHANGE switch at D.

(18) Tune test Receiver BC–652–A to 4,000 kc.

(19) Repeat (6) through (10) above for band D.

(20) Set the POWER AND EMISSION switch to CW FULL.

(21) Set the METER SW at PA PL.

(22) Adjust the antenna couplings for A, B, C, and D for maximum dip on the FIL & PL CURRENT meter. This should be about 5 for proper loading.

Note. The BAND CHANGE switch must be set for each preset band as its antenna coupling is tuned.

(23) Lock the antenna couplings for A, B, C, and D.

(24) Convert dummy antenna readings in amperes to watts by the use of the conversion chart. (See fig. 14.) The power output for each channel should be approximately as given in table VI.

31. Operational Test

a. Slide Radio Receiver BC–652–A and Radio Transmitter BC–653–A into position on Mounting FT–253–A and secure them in position with the five wingnuts provided along the lower edge of the front panels. This operation automatically connects the power supply leads and the interconnections to the radio transmitter. Connect the main power supply leads of Mounting FT–253–A to a 12-volt battery, making sure that each lead is connected in its proper polarity.

b. Connect dummy Antenna A–27–( ) between antenna binding post A of Radio Transmitter BC–653–A and ground. Place the auxiliary short-wave receiver near the dummy antenna so that it can pick up stray radiation. Connect a 12-volt battery to the auxiliary binding posts at the rear of this receiver.

c. Throw the ON-OFF switches of both receivers to ON. Plug Headset HS–18, HS–23–A, HS–30–( ), or Loudspeaker LS–3 into Radio Receiver BC–652–A. Rotate the INCREASE OUTPUT control until receiver hiss is heard, indicating that the vacuum tubes have warmed up and are functioning.

d. Start Radio Transmitter BC–653–A by turning the POWER AND EMISSION switch to CAL & NET. The dynamotor will start and the red pilot lamp will glow. Plug in Key J–45 and close it. The antenna break-in relay within Radio Transmitter BC–653–A will operate, and Radio Receiver BC–652–A on the mounting will be desensitized each time the key is closed. A 1,000-cycle sidetone will be heard in Headset HS–18, HS–23–A, HS–30–( ), or Loudspeaker LS–3.

e. Plug Headset HS–18, HS–23–A, HS–30–( ), or Loudspeaker LS–3 into the auxiliary receiver which is near the dummy antenna. Set the CW-MVC-AVC switch on this receiver at CW. Set the BAND CHANGE switch of the transmitter at PRESET FREQUENCY A. Tune the auxiliary receiver to this frequency. Operate Key J–45. Repeat this procedure for PRESET FREQUENCIES B, C, and D. The keying should be picked up by the auxiliary receiver. There should be no objectionable key clicks. Repeat this procedure for the tunable channel of the transmitter.

f. Set the METER SW of the transmitter to PA FIL, and adjust the PA FIL rheostat until the needle on the FIL & PL CURRENT meter points to the white triangle. With Key J–45 open, plug in Microphone T–17, T–30–A, or T–45 and turn the POWER AND EMISSION switch to VOICE. The dynamotor will stop running and the red pilot lamp will go out. Press the microphone button. This will start the dynamotor and will thus control Radio Transmitter BC–653–A for VOICE operation. Set the CW-MVC-AVC switch on the auxiliary receiver to AVC. Test Radio Transmitter BC–653–A on the four preset frequencies, and over the variable tuning range. At each frequency, tune the auxiliary receiver to the transmitter carrier and listen for clear and undistorted voice transmission.

g. Turn the transmitter POWER AND EMISSION switch OFF. Throw the ON-OFF switches of both receivers to OFF. Disconnect the power.

SECTION VIII

INDIVIDUAL STAGE AND CIRCUIT REPAIR DATA

32. Master-Oscillator Stage

a. STAGE DATA. (1) The m-o stage schematic is shown in figure 15.

(2) Resistance values for socket terminals of tube V100 to various points and to ground are shown on the tube socket layout. (See fig. 7.)

(3) Refer also to the following tables:

(*a*) Typical circuit resistances, table III.

(*b*) Filament and control voltages, table IV.

(*c*) Plate and screen voltages, table V.

(4) Parts data for the m-o stage is given in table VII.

b. TROUBLE LOCATION. (1) *Tube Check.* Remove Tube JAN–1613 (V100) from its socket. Test it on a tube checker, and replace it with a new tube if necessary. In replacing the tube, see that it is seated firmly in its socket.

(2) *Voltage and resistance checks.* Since the socket terminals of the various tubes in the transmitter are almost inaccessible, and since there are high voltages present, only resistance measurements will be made at the socket terminals, from the top, with the tubes and dynamotor removed and supply voltage off. See figures 7 and 15, and tables III, IV, and V, and check the resistances and voltages associated with the master oscillator. For r-f voltage checks, use an r-f vacuum-tube voltmeter with the low side connected to the transmitter frame and a 0.001-mf capacitor in series with the high side to block direct current. Perform the following checks for the presence of r-f voltage with your left hand in your pocket and your right hand holding the voltmeter probe carefully at the indicated test point. Check from the stators of capacitors C101, C102, C103, and C104 to ground with the BAND CHANGE switch set at PRESET FREQUENCIES A, B, C, and D, respectively; check from the stator of capacitor C105 to ground with BAND CHANGE switch set at either TUNABLE frequency, LF or HF. After trouble has been localized to a particular portion of the stage by the r-f and d-c measurements, make a check of each component associated with that portion of the stage. If r-f or d-c voltage is missing at any setting of the BAND CHANGE switch, check the components associated with that setting of the switch. With power off, check coils L100 and L101 for continuity, and check capacitor C100 to see that it has not been shorted by an r-f voltage surge. If plate or screen supply voltage is missing, check coils L102 and L103 and resistor R101 for continuity. Check plate coupling capacitor C112 to see that it is not shorted. With power and high voltage on, carefully parallel each fixed capacitor with another capacitor of approximately equal value, and observe the effect on the operation of the stage. This check is made to see if the various capacitors are open, a condition which would not be indicated by the usual continuity check.

(3) *Point-to-point continuity check.* If the preceding steps fail to indicate the cause of trouble, perform a point-to-point continuity check, referring to the stage schematic, figure 15, and to the practical wiring diagrams, figures 25 and 26. Check between the respective coils and capacitors of the tuned circuit and terminals 4 and 5 of socket V100 with the

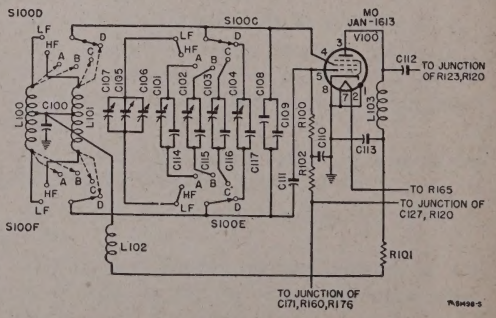


Figure 15. M-o stage schematic, Radio Transmitter BC–653–A.

tube removed and all power off, and the BAND CHANGE switch set at its various positions, to see if the BAND CHANGE switch sections S100C, D, E, and F are operative in all positions. Check for broken leads, faulty soldered joints and shorts.

(4) *Additional checks.* The bias for V100 is derived from a group of dropping resistors. The power supply is not grounded at B-, but at some point more positive than this; and bias for the grid of V100 is taken from a point negative with respect to ground. An open or short circuit in any of the dropping resistors, bypass capacitors, or blocking capacitors associated with the grid bias of the master oscillator will seriously affect operation of this stage; therefore these components should be carefully checked.

Table VII. Parts data, master oscillator stage. (See fig. 15.)

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C100	3D9200–21	CAPACITOR, fixed: mica; 200 mmf ±10%; 600 vdcw.	M-o plate bypass.
C101	3D9045V	CAPACITOR, variable: 35–310 mmf; 1,750 v rms, 60–c test.	M-o tuning for preset freq A.
C102	3D9045V	CAPACITOR: same as C101.	Tuning for preset freq B.
C103	3D9045V	CAPACITOR: same as C101.	Tuning for preset freq C.
C104	3D9045V	CAPACITOR: same as C101.	Tuning for preset freq D.
C105	3D9015V–7	CAPACITOR, variable: 15–25 mmf min to 292.7–308.3 mmf max; 1,750 v rms, 60–c test.	Tuning for calibrated channels.
C106	3D9006V	CAPACITOR, variable; 9–45 mmf; 1,750 v rms, 60–c test.	Alignment.
C107	3D9004V–1	CAPACITOR, variable; 7.5–27.5 mmf; 1,750 v rms, 60–c test.	Reset.
C108	3D9028	CAPACITOR: 28 mmf ±1 mmf.	Temp. comp.
C109	3D9070	CAPACITOR, fixed: mica; 70 mmf ±5%; 250 vdcw.	Fixed padder.
C110	3DA5–22	CAPACITOR: 0.005 mf ±10%; 300 vdcw.	Grid-leak bypass.
C111	3D9500–53	CAPACITOR: 500 mmf ±5%; 250 vdcw.	Grid.
C112	3DA2–57	CAPACITOR, fixed: mica; 0.002 mf ±5%; 500 vdcw.	Output coupling.
C113	3DA5–23	CAPACITOR, fixed: mica; 0.005 mf ±10%; 600 vdcw.	Plate bypass.
C114	3D9025–19	CAPACITOR, fixed: mica; 25 mmf ±5%; 250 vdcw.	Padder across C101.
C115	3D9025–19	CAPACITOR: same as C114.	Padder across C102.
C116	3D9025–19	CAPACITOR: same as C114.	Padder across C103.
C117	3D9025–19	CAPACITOR: same as C114.	Padder across C104.
L100	2C6530–653A/C14	COIL: tank.	M-o l-f tank.
L101	2C6530–653A/C2	COIL: tank.	M-o h-f tank.
L102	3C319	COIL.	Screen choke.
L103	3C319	COIL.	Plate choke.
R100	3Z6622–1	RESISTOR: metallized; 22,000 ohms ±10%; 2 w.	Grid leak.
R101	3Z6580–4	RESISTOR: wire-wound; 8,000 ohms ±10%; 4 w.	Plate.
R102	3Z6470–3	RESISTOR: metallized; 4,700 ohms ±10%; 1 w.	Decoupling.
S100C	2C6530–653A/S14/1	SWITCH: section of BAND CHANGE switch.	Capacitor (plate).
S100D	2C6530–653A/S14/1	SWITCH: same as S100C.	Capacitor (grid).
S100E	2C6530 653A/S14/1	SWITCH: Same as S100C.	Capacitor.
S100F	2C6530–653A/S14/1	SWITCH: same as S100C.	Coil.
V100	2T175	TUBE JAN–1613 (VT–175).	Master oscillator.
X100	2C6530–653A/S1	SOCKET.	M-o tube.

33. Intermediate-Power-Amplifier Stage

a. Stage Data. (1) I-p-a stage schematic is shown in figure 16.

(2) Resistance values for socket terminals of tube V120 to various points and to ground are shown on the tube socket layout, figure 7.

(3) Refer also to the following tables:

(*a*) Typical circuit resistances, table III.
(*b*) Filament and control voltages, table IV.
(*c*) Plate and screen voltages, table V.

(4) Parts data for the i-p-a stage is given in table VIII.

b. Trouble Location. (1) *Tube check.* Since V120 is a Tube JAN–807, it will not be possible to test this tube on the average tube checker; therefore a determination of the condition of the tube can be made only from voltage and resistance checks. If the following checks indicate that the tube is defective, replace it with a new tube. In replacing the tube, see that it is seated firmly in its socket and that the plate cap makes good contact.

(2) *Voltage and resistance checks.* Since the socket terminals of the various tubes in the transmitter are almost inaccessible, and since there are high voltages present, only resistance measurements will be made at the socket terminals, from the top, with the tubes and dynamotor removed and supply voltage off. Using figures 7 and 16, and tables III, IV, and V, check the resistances and voltages associated with the intermediate power amplifier. For r-f voltage checks, use an r-f vacuum-tube voltmeter with the low side connected to the transmitter frame and with a 0.001-mf capacitor in series with the high side to block direct current. Perform the following checks for the presence of r-f voltage with your left hand in pocket, and your right hand holding the voltmeter probe carefully at the indicated test point. Check from the stators of capacitors C121, C122, C123, and C124 to ground with the BAND CHANGE switch set at PRESET FREQUENCIES A, B, C, and D, respectively, and check from the stator of capacitor C105 to ground with the BAND CHANGE switch set at either TUNABLE frequency, LF or HF. After trouble has been localized to a particular portion of the stage by the r-f and d-c measurements, make a check of each component associated with that portion of the stage. If r-f or d-c voltage is missing at any setting of the BAND CHANGE switch, check the components associated with that setting of the switch. With the power off, check coils L120, L121, and L122 for continuity, and check capacitor C120 for a short circuit by unsoldering the leads which connect it to terminal 1 of coil L122 and to terminal F of coil L120 and terminal F of coil L121, as indicated on the practical wiring diagrams. (See figs. 25 and 26.) Check capacitor C128 for a short circuit with an ohmmeter. If plate or screen supply voltage is missing, also check resistors R121, R122, and R172. Check plate coupling capacitor C130 to see that it is not shorted. With power and high voltage on, carefully parallel each fixed capacitor with another capacitor of approximately equal value, and observe the effect on the operation of the stage. This check is made to see whether the various capacitors are open, a condition which would not be indicated by the usual continuity check.

(3) *Point-to-point continuity check.* If the preceding steps fail to indicate the cause of trouble, perform a point-to-point continuity check, referring to the stage schematic, figure 16, and to the practical wiring diagrams. (See figs. 25 and 26.) Check between the respective coils and capacitors of the tuned circuit and the plate cap and ground of tube V120, with all power off and with the BAND CHANGE switch set at its various positions, to see whether the BAND CHANGE switch sections S100A and B are operating in all positions. Check for broken leads, faulty soldered joints and shorts.

(4) *Additional checks.* The bias for Tube V120 is derived from a group of dropping resistors. The power supply is not grounded at B-, but at some point more positive than this, and bias for the grid of Tube V120 is taken from a point negative with respect to ground. An open or short circuit in any of the dropping resistors, bypass capacitors, or blocking capacitors associated with the grid bias of the intermediate power amplifier will seriously affect operation of this stage; therefore these components should be carefully checked.

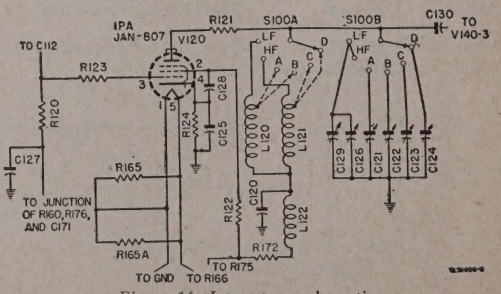


Figure 16. I-p-a stage schematic, Radio Transmitter BC–653–A.

Table VIII. Parts data, intermediate-power-amplifier stage. (See fig. 16.)

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C120	3DA5–21	CAPACITOR, fixed: mica; 0.005 mf ±10%; 600 vdcw.	I-p-a plate bypass.
C121	3D9025V–13	CAPACITOR, variable; 25–210 mmf; 1,750 v rms, 60-c test.	I-p-a tuning for preset freq A.
C122	3D9025V–13	CAPACITOR: same as C121.	Tuning for preset freq B.
C123	3D9025V–13	CAPACITOR: same as C121.	Tuning for preset freq C.
C124	3D9025V–13	CAPACITOR: same as C121.	Tuning for preset freq D.
C125	3DA5–23	CAPACITOR, fixed: mica; 0.005 mf ±10%; 600 vdcw.	Cathode bypass.
C126	3D9003–8	CAPACITOR, variable: 7.5–13.5 mmf.	Alignment.
C127	3DA5–23	CAPACITOR: same as C125.	Grid-leak bypass.
C128	3DA5–23	CAPACITOR: same as C125.	Screen bypass.
C129	3D9014V	CAPACITOR, variable: 14–22 mmf min to 161.5–169.5 mmf max; test v 2,500 v rms, 60-c test.	Tuning.
C130	3D9040–6	CAPACITOR, fixed: mica; 40 mmf ±5%; 600 vdcw.	P-a grid feed.
L120	2C6530–653A/C4	COIL: plate tuning.	I-p-a low frequency. 1-f.
L121	2C6530 653A/C5	COIL: same as L120.	I-p-a frequency.
L122	3C319	COIL: r-f choke.	Plate supply choke.
R120	3Z6622–1	RESISTOR: metallized; 22,000 ohms ±10%; 2 w.	Grid leak.
R121	3Z5995–6	RESISTOR: 5 ohms ±10%; 5 w.	Plate parasitic suppressor.
R122	3Z6622–1	RESISTOR: metallized; 22,000 ohms ±10%; 2 w.	Screen.
R123	3Z5995–6	RESISTOR: 5 ohms ±10%; 5 w.	Grid parasitic.
R124	3Z6039–1	RESISTOR: wire wound; 390 ohms ±10%; 2 w.	Cathode.
R165	3Z4815.1	RESISTOR: wire wound; 15 ohms ±5%; 8 w.	Filament.
R165A	3Z6003J1–1	RESISTOR: wire wound; 39 ohms ±10%; 2 w	I-p-a filament.
R172	3Z6016	RESISTOR: wire wound; 160 ohms ±5%; 1 w.	Plate metering.
S100A	2C6530–653A/S14/1	SWITCH: section of BAND CHANGE switch.	Plate tuning coil.
S100B	2C6530–653A/S14/1	SWITCH: same as S100A.	Plate tuning capacitor.
V120	2T100	TUBE JAN–807 (VT–100).	Intermediate power amplifier.
X120	2C6530–653A/S2	SOCKET.	I-p-a tube.

34. Power Amplifier Stage

a. Stage Data. (1) The p-a stage schematic is shown in figure 17.

(2) Resistance values for socket terminals of tubes V140 and V141 to various points and to ground are shown on the tube socket layout. (See fig. 7.)

(3) Refer also to the following tables:

(*a*) Typical circuit resistances, table III.
(*b*) Filament and control voltages, table IV.
(*c*) Plate and screen voltages, table V.

(4) Parts data for the p-a stage is given in table IX.

b. Trouble Location. (1) *Tube check.* Since V140 and V141 are Tubes JAN–814, it will not be possible to test these on the average tube checker; therefore a determination of the condition of these tubes can be made only from voltage and resistance checks. If the following checks indicate that either tube is defective, replace it with a new tube. In replacing the tube, see that it is seated firmly in its socket and that the plate cap makes good contact.

(2) *Voltage and resistance checks.* Since the socket terminals of the various tubes in the transmitter are almost inaccessible, and since there are high voltages present, only resistance measurements will be made at the socket terminals, from the top, with the tubes and dynamotor removed and supply voltage off. Using figures 7 and 17, and tables III, IV and V, check the resistances and voltages associated with the power amplifier. For r-f voltage checks, use an r-f vacuum-tube voltmeter with the low side connected to the transmitter frame and with a 0.001-mf capacitor in series with the high side to block direct current. Perform the following checks for the presence of r-f voltage with your left hand in your pocket, and your right hand holding the voltmeter probe carefully at the indicated test point. Check from the stators of capacitors C141, C142, C143, and C144 to ground with the BAND CHANGE switch set at PRESET FREQUENCIES A, B, C, and D, respectively, and check from the stator of capacitor C145 to ground, with the BAND CHANGE switch set at either TUNABLE frequency, LF or HF. After trouble has been localized to a particular portion of the stage by the r-f and d-c measurements, make a check of each component associated with that portion of the stage. If r-f or d-c voltage is missing at any setting of the BAND CHANGE switch, check the components associated with that setting of the switch. With the power off, check coils L143, L144, and L145 for continuity, and check resistor R179 and capacitor C150 (located near the plate caps of tubes V140 and V141) for proper functioning. If plate or screen supply voltage is missing, check also coils L141 and L142. Check plate coupling capacitor C150 to see that it is not shorted, and check resistor R179 to see that it is not open. With the power and high voltage on, carefully parallel each fixed capacitor with another capacitor of approximately equal value, and observe the effect on the operation of the stage. This check is made to see if the various capacitors are open, a condition which would not be indicated by the usual continuity check.

(3) *Point-to-point continuity check.* If the preceding steps fail to indicate the cause of trouble, perform a point-to-point continuity check, referring to the stage schematic, figure 17, and to the practical wiring diagrams, figures 25 and 26. With all power off, check to see that the high terminals of the capacitors and the taps of coil L143 are connected to the antenna side of capacitor C150 and to terminal H of relay K161. With the BAND CHANGE switch set at its various positions, check to see whether the BAND CHANGE switch sections S140A and B are operative in all positions. Check for broken leads, faulty soldered joints, and short circuits.

(4) *Additional checks.* The bias for tubes V140 and V141 is derived from a group of dropping resistors. The power supply is not grounded at B-, but at some point more positive than this, and bias for the grids of V140 and V141 is taken from a point negative with respect to ground. An open or short circuit in any of the dropping resistors, bypass

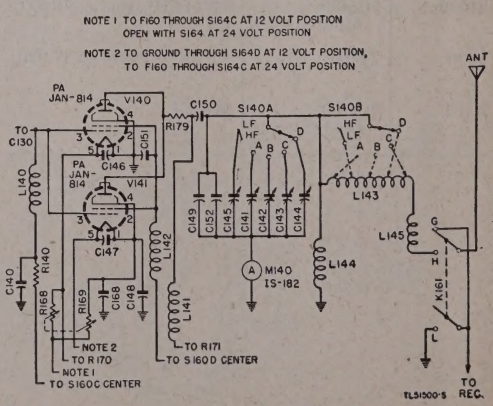


Figure 17. P-a stage schematic, Radio Transmitter BC–653–A.

capacitors, or blocking capacitors associated with the grid bias of the power amplifier will seriously affect operation of this stage; therefore these components should be carefully checked. Rheostat R177 in the grid-bias network provides a variable bias voltage for the grids of the p-a tubes when the POWER AND EMISSION switch is at VOICE. If there is any doubt as to the proper setting of rheostat R177, see paragraph 17 for the method of determining the proper setting of this rheostat.

Table IX. Parts data, power-amplifier stage. (See fig. 17.)

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C140	3D9500–47	CAPACITOR, fixed: mica; 500 mmf ±10%; 1,200 vdcw.	P-a grid-leak bypass.
C141	3D9033V	CAPACITOR, variable: 33–473 mmf; 1,750 v rms, 60–c test.	Antenna coupling for preset freq A.
C142	3D9033V	CAPACITOR: same as C141.	Antenna coupling for preset freq B.
C143	3D9033V	CAPACITOR: same as C141.	Antenna coupling for preset freq C.
C144	3D9033V	CAPACITOR: same as C141.	Antenna coupling for preset freq D.
C145	3D9033V–1	CAPACITOR: same as C141.	Antenna coupling for calibrated freq.
C146	3DA5–22	CAPACITOR: 0.005 mf ±10%; 300 vdcw.	P-a filament bypass.
C147	3DA5–22	CAPACITOR: same as C146.	Filament bypass.
C148	3DA5–23	CAPACITOR: 0.005 mf ±10%; 600 vdcw.	Filament bypass.
C149	3D9045–3	CAPACITOR, fixed: ceramic; 45 mmf ±5 mmf.	Fixed padder.
C150	3DA5–26	CAPACITOR, fixed: mica; 0.005 mf ±10%; 2.500 vdcw.	Plate blocking.
C151	3DA5–41	CAPACITOR: same as C150.	Screen bypass.
C152	3D9045–3	CAPACITOR, fixed: ceramic; 45 mmf ±5 mmf.	Fixed padder.
C168	3DA20–21	CAPACITOR, fixed: mica; 0.02 mf ±10%; 600 vdcw.	P-a circuit hash filter.
K161	2C6530–653A/R1	RELAY.	Key.
L140	3C319	COIL.	P-a grid choke.
L141	3C319	COIL.	P-a plate supply choke.
L142	3C319	COIL.	P-a screen choke.
L143	2C6530–653A/C6	COIL.	P-a tank.
L144	2C6530–653A/C7	COIL.	Antenna drain choke.
L145	2C6530–653A/C8	COIL.	Antenna load.
M140	3F382	AMMETER 1S–182: 0–6 amp r-f with internal thermocouple.	Antenna current.
R140	3Z6400–19	RESISTOR: wire-wound; 4,000 ohms ±5%; 4 w.	Grid leak.
R168	3Z4815–1	RHEOSTAT: 2 resistors, each 1.3 ohms ±10%; 4.2 amp; (includes R169).	Filament.
R169	3Z4815–1	RHEOSTAT: same as and included with R168.	Filament.
R179	3Z5995–6	RESISTOR: 5 ohms ±10%; 5 w.	Plate dropping resistor.
S140A	2C6530/653A/S15/1	SWITCH: part of switch ass'y ML–7763616–G2.	Capacitor.
S140B	2C6530–653A/S15/1	SWITCH: same as S140A.	P-a coil.
V140	2T154	TUBE: JAN–814 (VT–154).	Power amplifier.
V141	2T154	TUBE: JAN–814 (VT–154).	Power amplifier.
X140	2C6530–653A/S2	SOCKET:	P-a tube.
X141	2C6530–653A/S2	SOCKET:	P-a tube.

35. Modulator Stage

a. STAGE DATA. (1) The modulator stage schematic is shown in figure 18.

(2) The following tables contain information and values to be used in localizing trouble within the stage:

(*a*) Typical circuit resistance, table III.
(*b*) Filament and control voltages, table IV.
(*c*) Plate and screen voltages, table V.

(3) See also the voice operation test for sidetone, paragraph 29*b*.

(4) Parts data for the modulator stage is given in table X.

b. TROUBLE LOCATION. (1) *Tube check.* Remove V180, Tube JAN–1613, from its socket. Test on a tube checker and replace it with a new tube if necessary. In replacing the tube, see that it is seated firmly in its socket.

(2) *Voltage and resistance checks.* Since the socket terminals of the various tubes in the transmitter are almost inaccessible, no voltage and resistance measurements can be made at the bottom of the tube sockets. Instead, measurements at various equivalent test points are given. Using figure 18 and tables III, IV, and V, check the resistances and voltages associated with the modulation stage. See the voice sidetone test in paragraph 29*b*. This test is a good check of the operation of the modulator stage as a whole.

(3) *Point-to-point continuity check.* If the preceding steps fail to indicate the cause of trouble, perform a point-to-point continuity check, referring to the stage schematic, figure 18, and to the practical wiring diagrams, figures 25 and 26. Check for proper operation of the POWER AND EMISSION switch in all positions of that switch. Check for broken leads, faulty soldered joints and shorts.

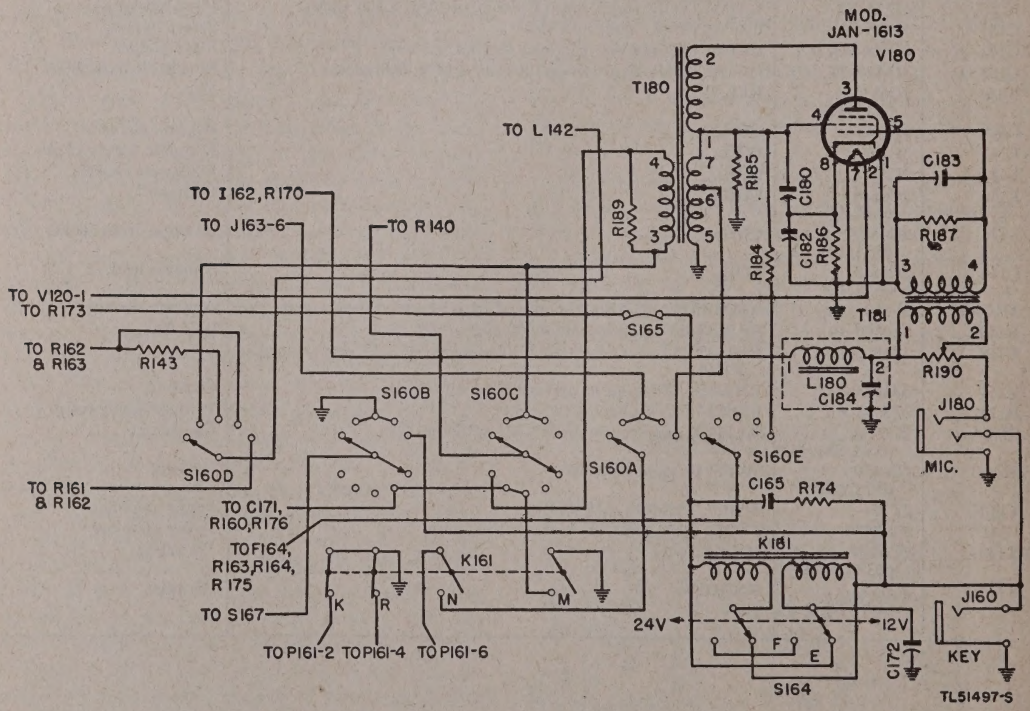


Figure 18. Modulator stage schematic, Radio Transmitter BC–653–A.

Table X. Parts data, modulator stage. (See fig. 18.)

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C165	3DB1.467	CAPACITOR: 1.0 mf; 600 vdcw.	Keying filter.
C172	3DA5–22	CAPACITOR: 0.005 mf ±10%; 300 vd cw.	Relay coil hash filter.
C180	3DB1.017	CAPACITOR: pyranol; 1.0 mf; 500 vdcw.	Plate bypass modulator tube.
C182	3DB25–7	CAPACITOR: electrolytic; 25 mf ±100%, −10%; 50 v dc test.	Plate bypass.
C183	3D9100–50	CAPACITOR, fixed: mica; 100 mmf ±10%; 500 vdcw.	Grid.
C184	3DB25–8	CAPACITOR: electrolytic; 25 mf +100%, −10%; 50 v max; (included with L180).	Microphone filter.
J160	2C4452A/J1	JACK JK–34–A.	Key.
J180	2Z5533A	JACK JK–33–A.	Microphone.
K161	2C6530–653A/R1	RELAY.	Key.
L180	2C6530–653A/C10	COIL: (includes C184).	Microphone filter choke.
R143	3Z6656–2	RESISTOR: metallized; 56,000 ohms ±10%; 2 w.	Modulation voltage dropping.
R174	3Z5994G7	RESISTOR: wire-wound; 4.7 ohms ±10%; 1 w.	Key relay coil filter.
R184	3Z5420.7	RESISTOR: wire-wound; 2,000 ohms ±5%; 20 w.	Bias.
R185	3Z6618–11	RESISTOR: wire-wound; 18,000 ohms ±10%; 12 w.	Bias.
R186	3Z6043	RESISTOR: wire-wound; 430 ohms ±5%; 2 w.	Bias.
R187	3Z6733–1	RESISTOR: metallized; 330,000 ohms ±10%; ½ w.	Modulator input transformer.
R189	3Z6575–16	RESISTOR: metallized; 7,500 ohms ±5%; 2 w.	Modulator input transformer.
R190	3Z6020–19	RESISTOR: 200 ohms, 0.14 amp.	Input level.
S160A	2C6530–653A/S16	SWITCH: (included with S160).	Sidetone selector.
S160B	2C6530–653A/S16	SWITCH: (included with S160).	Dynamotor relay and keying bias.
S160C	2C6530–653A/S16	SWITCH: (included with S160).	C-w voice bank.
S160D	2C6530–653A/S16	SWITCH: (included with S160).	P-a screen modulator voltage.
S160E	2C6530–653A/S16	SWITCH: (included with S160).	Modulator plate bank.
S164	2C6530–653A/L2	LINK BOARD: (includes S164A,B,C,D,E, and F).	Transmitter.
S164E		SWITCH: (included in S164).	Key relay coil.
S164F		SWITCH: (included in S164).	Key relay coil.
S165	3Z9811–1	INTERLOCK: part of switch ass'y (ML–7763616–G2.	Key relay.
T180	2C6530–653A/T4	TRANSFORMER.	Modulation.
T181	2C6530–653A/T5	TRANSFORMER.	Microphone.
V180	2T175	TUBE JAN–1613 (VT–175).	Modulator.
X180	2C6530–653A/S6	SOCKET.	Modulator tube.

36. Auxiliary Switching, Metering, and Power Circuits

a. Stage Data. (1) The auxiliary switching, metering, and power circuits schematic is shown in figure 19.

(2) The following functional schematics will be helpful in understanding the operation of this stage:

(*a*) Basic filament circuits, figure 20.
(*b*) Basic control circuits, figure 21.
(*c*) Basic break-in relay circuits, figure 22.

(3) Refer also to the following tables:

(*a*) Typical circuit resistances, table III.
(*b*) Filament and control voltages, table IV.
(*c*) Plate and screen voltages, table V.

(4) Parts data for the auxiliary switching, metering, and power circuits is given in table XI.

b. Trouble Location. (1) *Tube check.* The average tube checker is not capable of checking voltage regulator tubes; therefore these tubes must be checked in operation. If the voltage at coil L102 approximately is 210 ± 15 volts, tubes V160 and V161 are functioning properly. Ballast resistor R167 is checked as follows: With all links set for 24-volt operation, remove resistor R167 from its socket and place a 0-5 d-c ammeter (the 0-5 r-f ammeter of previous tests may be used) in series with one of the two active pins. Connect a lead from the free terminal of the ammeter to the point in the socket where the corresponding pin originally fitted. Connect a lead from the remaining pin to the point in the socket where this pin originally fitted. Make certain that all leads are secure. With the set in operation, increase the external supply voltage to 28 volts, and measure the potential across resistor R167 with a d-c voltmeter. This potential, divided by the current indicated by the ammeter, should give a value of 9.5 ohms for the hot resistance of resistor R167 with a 28-volt supply.

(2) *Voltage and resistance checks.* The checks are made in this stage to determine the distribution of supply voltages, the continuity of control circuits, and the proper functioning of relays and switches. See figures 19, 20, 21, and 22, and tables III, IV, and V. Perform the indicated measurements.

(3) *Point-to-point continuity check.* If the preceding steps fail to indicate the cause of the trouble, perform a point-to-point continuity check, referring to the stage schematic (fig. 19), the functional break-downs (figs. 20, 21, and 22) and the practical wiring diagrams (figs. 25 and 26). Check all fuses, chokes, interlocks, and rotary switches. Check to see that all links are making good contact. Check for broken leads, faulty soldered joints, and shorts.

(4) *Notes on functional schematics.* These notes apply to the schematics of figures 20, 21, and 22.

(*a*) *Basic Filament Circuits* (*fig. 20*). Note that the receiver OFF-ON switch controls the filaments of the cathode-heater tubes of the transmitter. Each p-a tube has its own filament rheostat. These two rheostats, R168 and R169, are mechanically ganged. In the upper schematic, indicating 12-volt operation, the filaments of tubes V140 and V141 are connected in parallel. In the lower schematic, indicating 24-volt operation, note the addition of ballast resistor R167, which drops the 24-volt supply to 12 volts for the cathode-heater tubes. On 24-volt operation, the filaments of tubes V140 and V141 are connected in series.

(*b*) *Basic Control Circuits* (*fig. 21*). On 12-volt operation, in the VOICE position of the POWER AND EMISSION switch S160B, dynamotor relay K160 is energized by the closing of the press-to-talk switch on Microphone T–17 or T–30–A. Note that the receiver OFF-ON switch must be ON in order to operate transmitter. On 24-volt operation, the connections are the same as above, except that resistor R173 is inserted in the coil circuit of relay K160, resistor R167 is placed in series with the line to the m-o i-p-a, and modulator filaments, and Dynamotor DM–43–A is used instead of Dynamotor DM–42–A.

(*c*) *Basic Break-in Relay Circuits* (*fig. 22*). The connections for 12-volt operation are exactly as shown in figure 22. For 24-volt operation, the connections are the same as shown, except that the coils of relay K161 are connected in series instead of in parallel. This is done with the links of S164F and E. Sidetone of 1,000 cycles now comes from Dynamotor DM–43–A instead of Dynamotor DM–42–A.

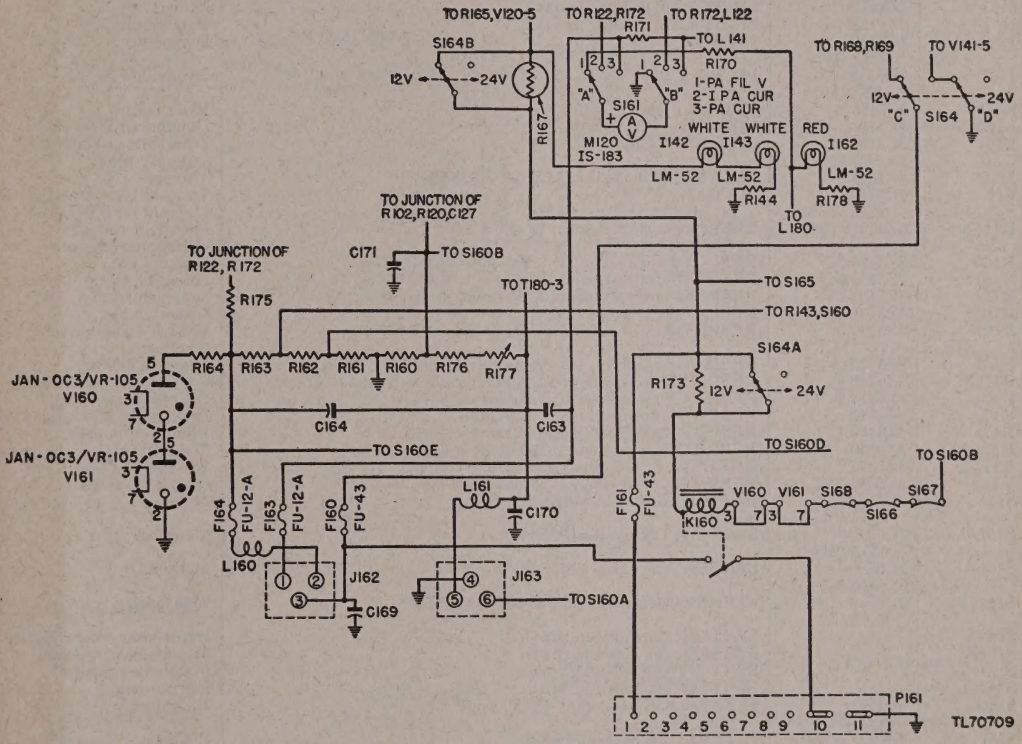


Figure 19. Auxiliary switching, metering and power circuits, Radio Transmitter BC-653-A.

Table XI. Parts data, auxiliary switching, metering, and power circuits. (See fig. 19.)

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C163	3DB1.300	CAPACITOR: pyranol; 1.0-mf +10%, −2½%; 1,200 vdcw.	High-voltage dynamotor filter.
C164	3DB1.300	CAPACITOR: same as C163.	High-voltage dynamotor filter.
C169	3DA25–5	CAPACITOR: 0.025 mf ±10%; 400 vdcw.	Low-voltage hash filter.
C170	3DA50–52	CAPACITOR: 0.05 mf ±10%; 400 vdcw.	B minus hash filter.
C171	3DA50–52	CAPACITOR: same as C170.	Grid-return hash filter.
F160	3Z1943	FUSE FU–43: 10 amp; 25 v.	P-a filament.
F161	3Z1943	FUSE FU–43: 10 amp; 25 v.	M-o filament.
F163	3Z1912A	FUSE FU–12–A: ½ amp; 1,000 v.	High voltage.
F164	3Z1912A	FUSE FU–12–A: ½ amp; 1.000 v.	High voltage.
I142	2Z5952	PILOT LAMP LM–52: 0.150 amp; 6–8 v.	P-a coil.
I143	2Z5952	PILOT LAMP: same as I142.	P-a coil.
I162	2Z5952	PILOT LAMP: same as I142.	Dynamotor.
J162	2C6530–653A/J9	JACK.	Dynamotor.
J163	2C6530–653A/J10	JACK.	Dynamotor.
K160	2Z7648	RELAY.	Dynamotor.
L160	3C319	COIL.	Dynamotor filter choke.
L161	3C319	COIL.	Dynamotor negative supply filter.
M120	3F7383	VOLTMETER IS–183: 15 v dc; 3,800 ohm.	Tuning.
P161	2C6530–653A/T3	PLUG.	Transmitter connector to mounting FT–253–A.
R144	3Z6001E10	RESISTOR: wire-wound; 15 ohms ±10%; ½ w.	Pilot light voltage dropping resistor.
R160	3Z5425.2	RESISTOR: wire-wound; 2,500 ohms ±5%; 25 w.	Keying bias.
R161	3Z5450.6	RESISTOR: wire-wound; 5,000 ohms ±5%; 25 w.	Potentiometer.
R162	3Z5431A5	RESISTOR: wire-wound; 3,150 ohms ±5%; 25 w.	Screen divider.
R163	3Z5431A5	RESISTOR: same as R162.	Screen divider.
R164	3Z5450.6	RESISTOR: wire-wound; 5,000 ohms ±5%; 25 w.	Voltage regulator tube ballast.
R167	3Z6925–5	RESISTOR: ballast; 1.3 ohms cold; 9.5 ohms at 28 vdcw.	Filament series.
R170	3Z6240–6	RESISTOR: wire-wound; 2,400 ohms ±5%; 1 w.	P-a filament metering.
R171	3Z4825.2	RESISTOR: wire-wound; 25 ohms ±5%; 8 w.	P-a plate metering.
R173	3Z4816	RESISTOR: wire-wound; 16 ohms ±5%; 20 w.	Dynamotor relay series.
R175	3Z5460.1	RESISTOR: wire-wound; 6,000 ohms ±5%; 20 w.	I-p-a plate supply.
R176	3Z4960	RESISTOR: wire-wound; 160 ohms ±5%.	Fixed P-a bias.
R177	3Z7025	RHEOSTAT: 225 ohms ±10%; 0.394 amp.	Variable P-a bias.
R178	3Z6003J1–1	RESISTOR: wire-wound; 39 ohms ±10%; 2 w.	Pilot lamp series.
S161	2C6530–653A/S17	SWITCH: (includes S161A and B).	Metering.
S161A	2C6530–653A/S18	SWITCH: (included with S161).	Metering.
S161B	2C6530–653A/S18	SWITCH: (included with S161).	Metering.
S164	2C6530–653A/L2	LINK BOARD: (includes S164A,B,C,D,E,F).	Transmitter.
S164A		SWITCH: (included in S164).	Dynamotor relay resistor.
S164B		SWITCH: (included in S164).	M-o filament resistor.
S164C		SWITCH: (included in S164).	P-a filament resistor.
S164D		SWITCH: (included in S164).	P-a filament.
S166	3Z9692–3592D	INTERLOCK: 3 amp at 250 v; single ckt.	I-p-a door.
S167	3Z9692–3592D	INTERLOCK: same as S166.	P-a door.
S168	3Z9692–3592D	INTERLOCK: same as S166.	Dynamotor.
V160	2T200	TUBE JAN–0C3/VR–105 (VT–200).	Voltage regulator.
V161	2T200	TUBE JAN–0C3/VR–105 (VT–200).	Voltage regulator.
X142	2C6530–653A/S5	SOCKET.	Upper P-a coil lamp.
X143	2Z5883–30	SOCKET.	Lower PA coil lamp.
X160	2C6530–653A/S6	SOCKET.	Voltage regulator tube.
S161	2C6530–653A/S6	SOCKET.	Voltage regulator tube.
X162	2C6530–653A/S7	SOCKET.	Regulator tube pilot lamp.

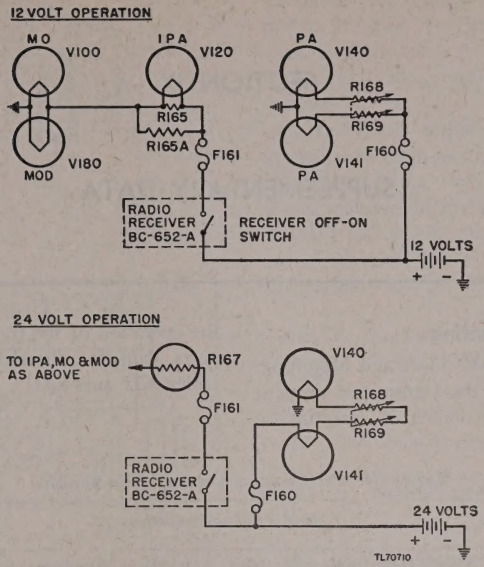


Figure 20. Functional schematic, basic filament circuits, Radio Transmitter BC–653–A.

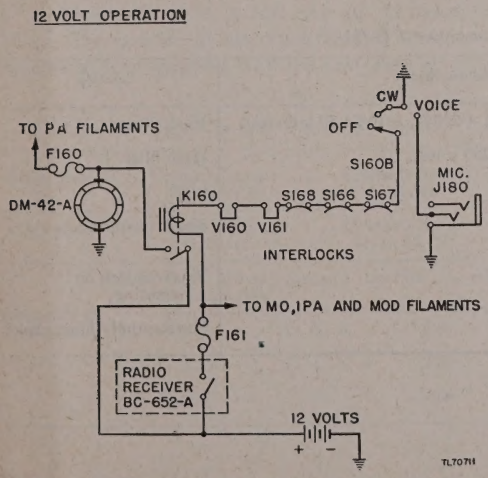


Figure 21. Functional schematic, basic control circuits, Radio Transmitter BC–653–A.

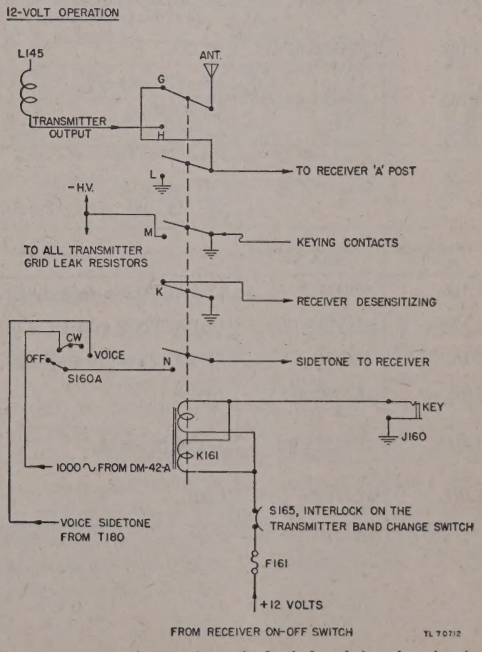


Figure 22. Functional schematic, basic break-in relay circuits, Radio Transmitter BC–653–A.

SECTION IX

SUPPLEMENTARY DATA

37. Dynamotor and Mounting

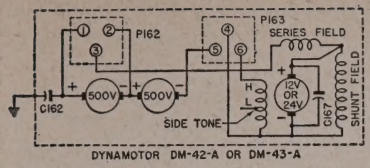
Dynamotor DM–42–A or DM–43–A and Mounting FT–253–A are not part of the transmitter proper, but since their correct functioning is essential to the operation of the transmitter, the schematics and parts data for these are given in figure 23 and tables XII and XIII.

Table XII. Parts data, dynamotor. (See fig. 23.)

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C162	3DA15–7	CAPACITOR, fixed: mica; 0.015 mf ±10%; 2,500 vdcw.	High-voltage dynamotor bypass.
C167	3DB25–7	CAPACITOR: electrolytic; 25 mf +200%, −10%; 50 v test.	Hash filter.
D160 or	3H1642A	DYNAMOTOR DM–42–A: 268 w, 1,030 v, 260 ma d-c; 110 w, 515 v, 215 ma d-c; when operated from 14 v dc power source.	Transmitter.
D161	3H1643A	DYNAMOTOR DM–43–A: same as D160 when operated from 28-v d-c power source.	Transmitter.
P162	2C6530–653A/P3	PLUG.	Dynamotor.
P163	2C6530–653A/P4	PLUG.	Dynamotor.

Table XIII. Parts data, mounting FT–253–A.

Reference symbol	Signal Corps stock No.	Name of part and description	Function
C166	3DB25–7	CAPACITOR: electrolytic; 25 mf +200%, −10%; 50 v dc test.	Hash filter.
C173	3DA100–127	CAPACITOR: 0.1 mf ±10%; 1,200 v test.	Hash filter.
F162	3Z1944	FUSE FU–44: 70 amp, 250 v.	Line.
J161	2C6530–653A/T2	JACK.	Shock mounting.
J302A	2C4452A/J2	JACK JK–34–A.	Receiver jack on mounting.
L162	3C324–5	COIL.	Power-supply filter choke.



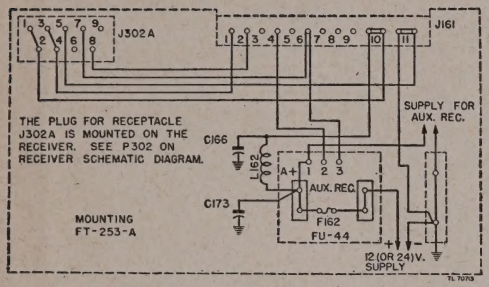


Figure 23. Mounting and dynamotor schematic, Radio Transmitter BC–653–A.

38. Break-in Relay Adjustments

a. Occasional inspection of the contacts of break-in relay K161 is necessary to insure proper operation. Dirty contacts should be cleaned with a very fine abrasive, such as crocus cloth or rouge paper. *Do not use a file on the contacts.* Contact sequence must be maintained to prevent excessive sparking. Under normal operation only a minimum of sparking should be noticeable.

b. Figure 24 shows a top view of the break-in relay. The position of the contacts as shown corresponds to their position with the key open, or with all power off. Proper operation of Radio Transmitter BC–653–A requires that the sequence of closure of the relay contacts be in a definite order. Table XIV illustrates proper adjustment of the contacts.

c. Individual order of closure within any one group, as listed in sequence of closure of table XIV, is not important. It is essential, however, that the group sequence be maintained. Relay K161 is heavily built and should not ordinarily require mechanical adjustment. Table XV explains the functions of the various contacts of the break-in relay.

Table XIV. Break-in relay, contact adjustment

Relay closed:	Contacts closed; H, L, M, N.		Contacts open; G, K, R.
Relay open:	Contacts closed; G, K, R.		Contacts open; H, L, M, N.
Sequence of closure:	As relay closes, contacts operate in the following order:		
	Group 1	G, K, R	open
	Group 2	H, L, N	close
	Group 3	M	closes

Table XV. Break-in relay, contact functions. (See fig. 24.)

Contact	Function
G	Antenna transfer to Radio Receiver BC–652–A.
H	Antenna transfer to Radio Transmitter BC–653–A.
K, R	Receiver desensitizing (a second or auxiliary receiver in use is also desensitized).
L	Receiver antenna grounding.
M	Keying circuit.
N	Sidetone keying.

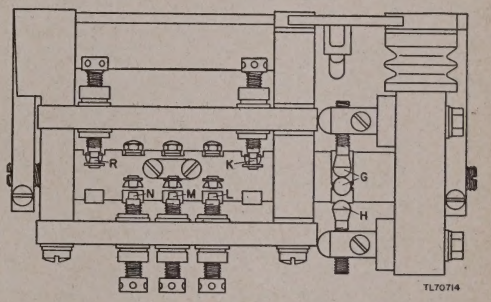


Figure 24. Break-in relay, Radio Transmitter BC–653–A.

39. Metering Constants

Since the FIL & PL CURRENT meter is used to measure current and voltage in three different circuits, it requires a group of multiplying constants to connect its indication into standard units. When the METER SW is tuned to PA FIL, the meter reads d-c volts directly across the filament of one of the p-a tubes. In the IPA PL position, readings must be multiplied by 7 to obtain i-p-a plate current in milliamperes. P-a plate current in milliamperes is obtained by multiplying the reading in the PA PL position by 40.

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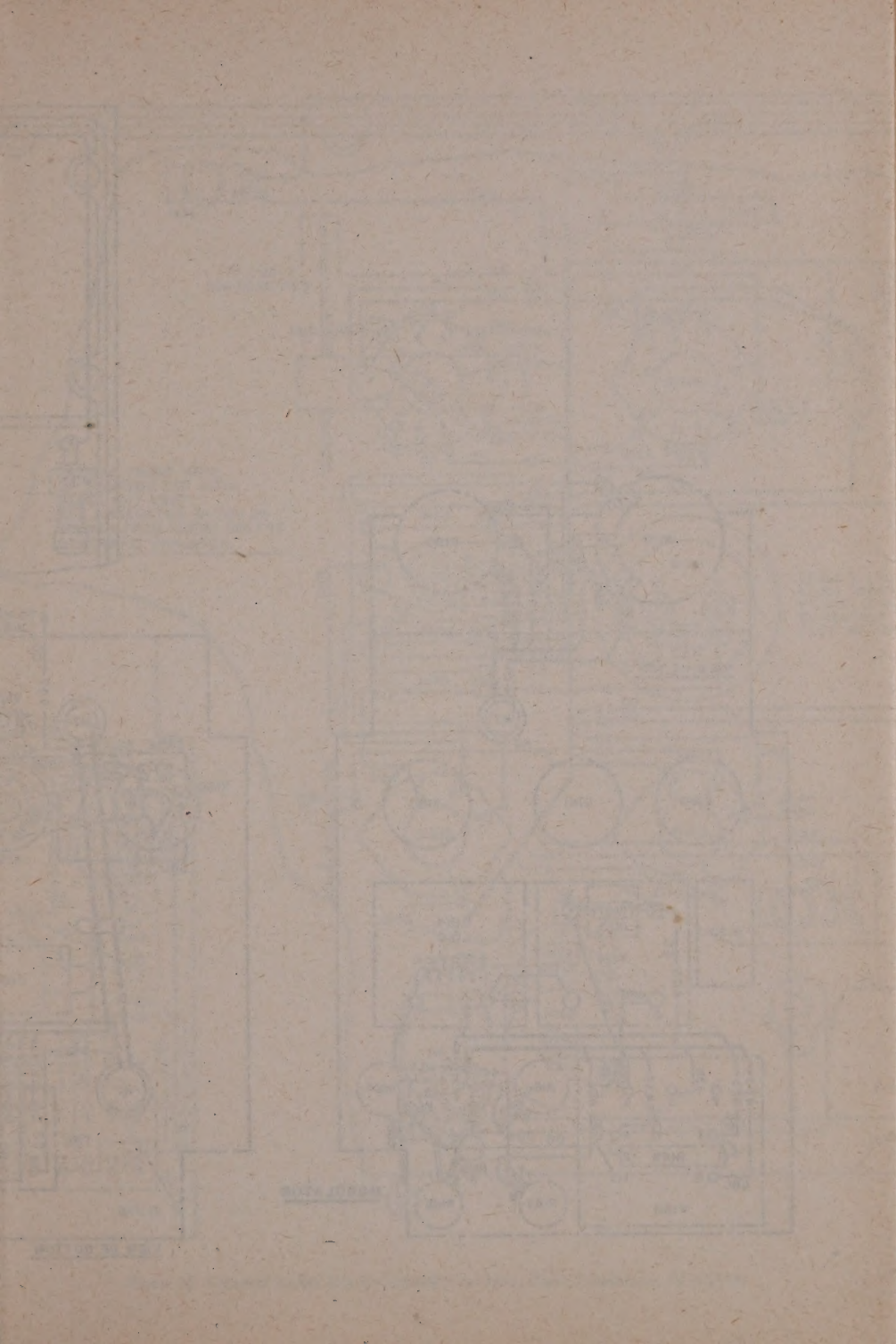

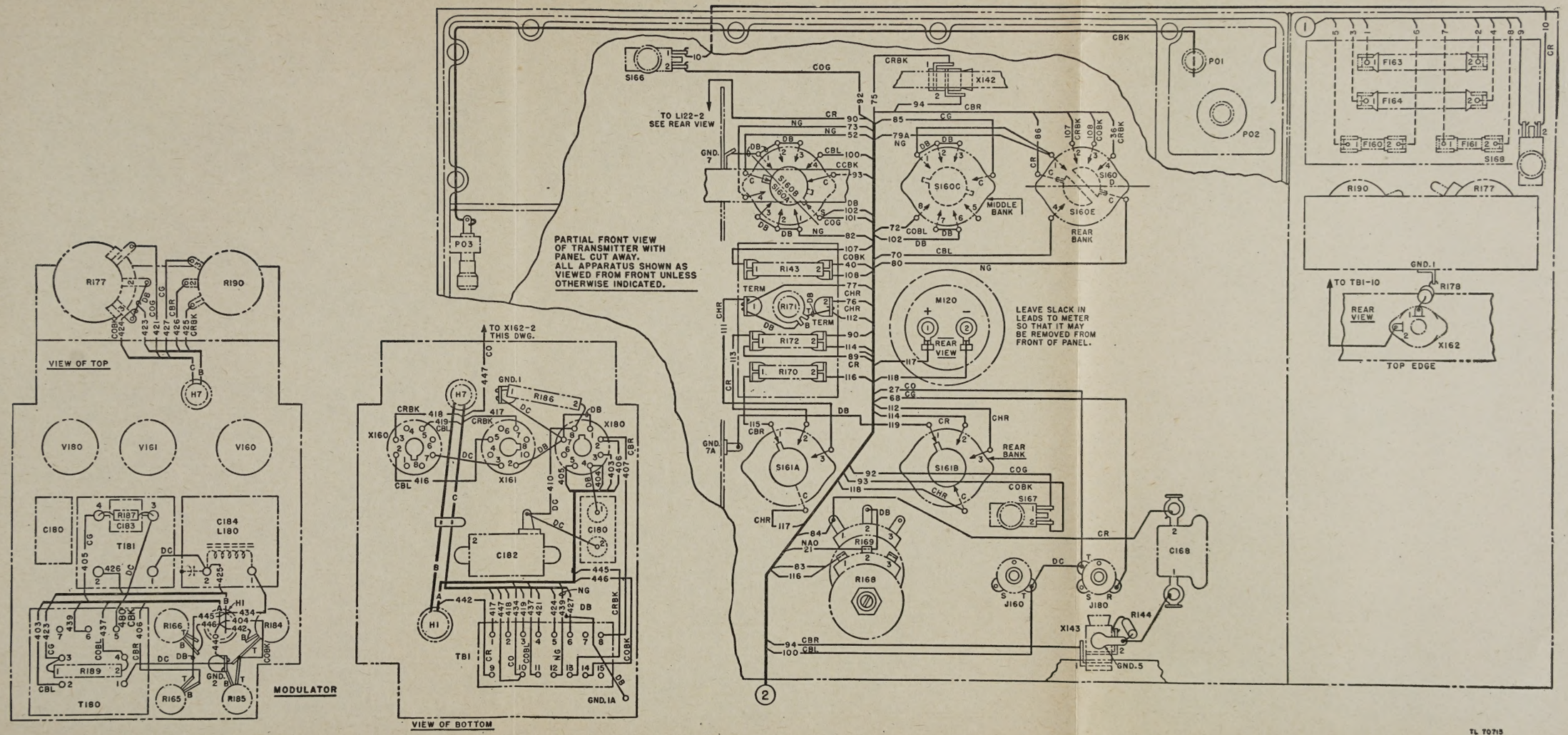

Figure 25. Practical wiring diagram, partial front view, Radio Transmitter, BC–653–A.

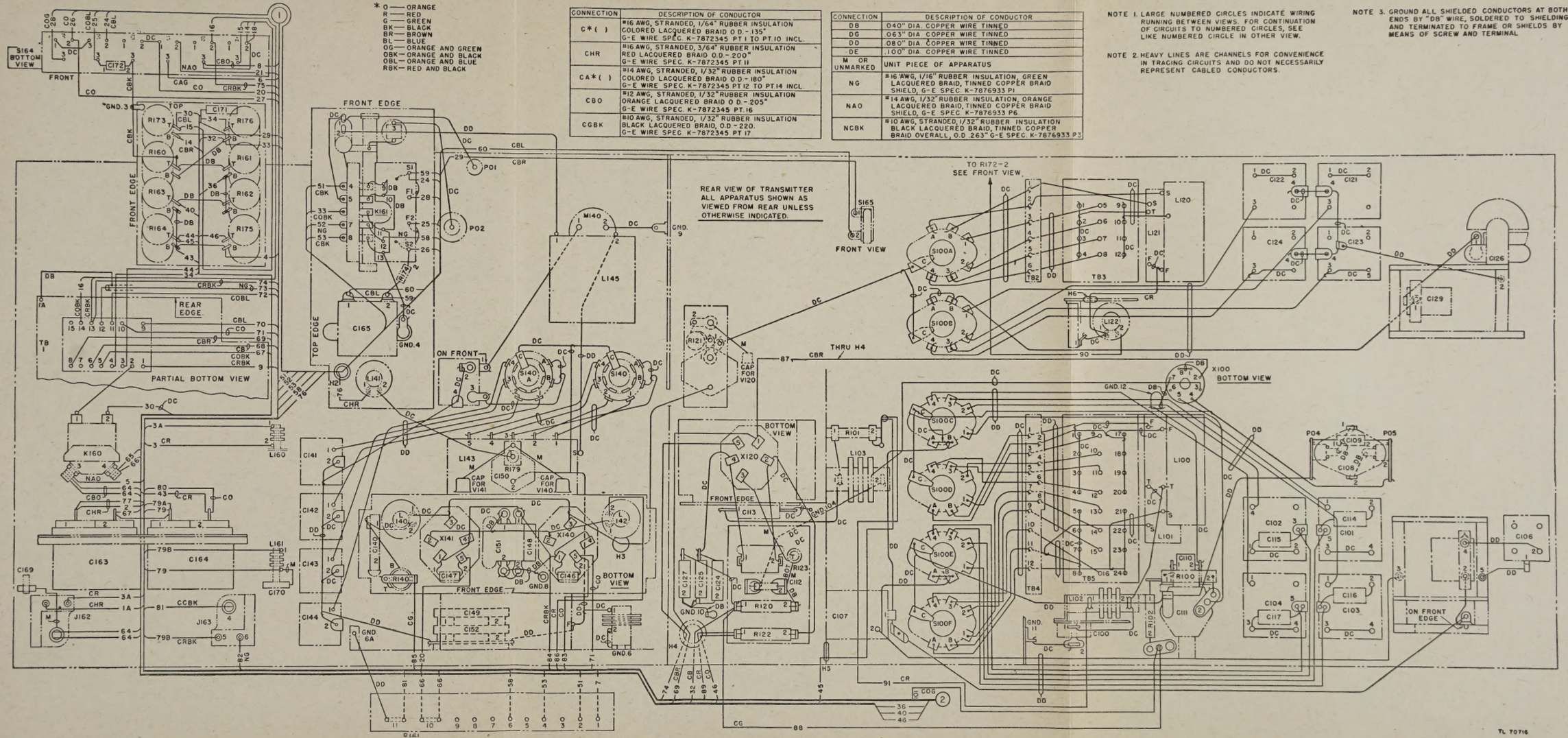

Figure 26. Practical wiring diagram, rear view, Radio Transmitter BC–653–A.

C100	200	MMF	C142	33-473	MMF	R122	22M	Ω
C101	35-310	MMF	C143	33-473	MMF	R123	5	Ω
C102	35-310	MMF	C144	33-473	MMF	R124	390	Ω
C103	35-310	MMF	C145	33-473	MMF	R140	4M	Ω
C104	35-310	MMF	C146	.005	MF	R143	56M	Ω
C105	25-308.3	MMF	C147	.005	MF	R144	15	Ω
C106	9-45	MMF	C148	.005	MF	R160	2,500	Ω
C107	7.5-27.5	MMF	C149	45	MMF	R161	5M	Ω
C108	28	MMF	C150	.005	MF	R162	3,150	Ω
C109	70	MMF	C151	.005	MF	R163	3,150	Ω
C110	.005	MF	C152	45	MMF	R164	5M	Ω
C111	500	MMF	C162	.015	MF	R165	15	Ω
C112	.002	MF	C163	1.0	MF	R165A	39	Ω
C113	.005	MF	C164	1.0	MF	R167	1.3	Ω
C114	25	MMF	C165	1.0	MF	R168	1.3	Ω
C115	25	MMF	C166	25	MF	R169	1.3	Ω
C116	25	MMF	C167	25	MF	R170	2,400	Ω
C117	25	MMF	C168	.02	MF	R171	25	Ω
C120	.005	MF	C169	.025	MF	R172	160	Ω
C121	25-210	MMF	C170	.05	MF	R173	16	Ω
C122	25-210	MMF	C171	.05	MF	R174	4.7	Ω
C123	25-210	MMF	C172	.005	MF	R175	6M	Ω
C124	25-210	MMF	C173	0.1	MF	R176	160	Ω
C125	.005	MF	C180	1.0	MF	R177	225	Ω
C126	7.5-13.5	MMF	C182	25	MF	R178	39	Ω
C127	.005	MF	C183	100	MMF	R179	5	Ω
C128	.005	MF	C184	25	MF	R184	2M	Ω
C129	14-161.5	MMF	R100	22M	Ω	R185	18M	Ω
	22-169.5	MMF	R101	8M	Ω	R186	430	Ω
C130	40	MMF	R102	4,700	Ω	R187	330M	Ω
C140	500	MMF	R120	22M	Ω	R189	7,500	Ω
C141	33-473	MMF	R121	5	Ω	R190	200	Ω

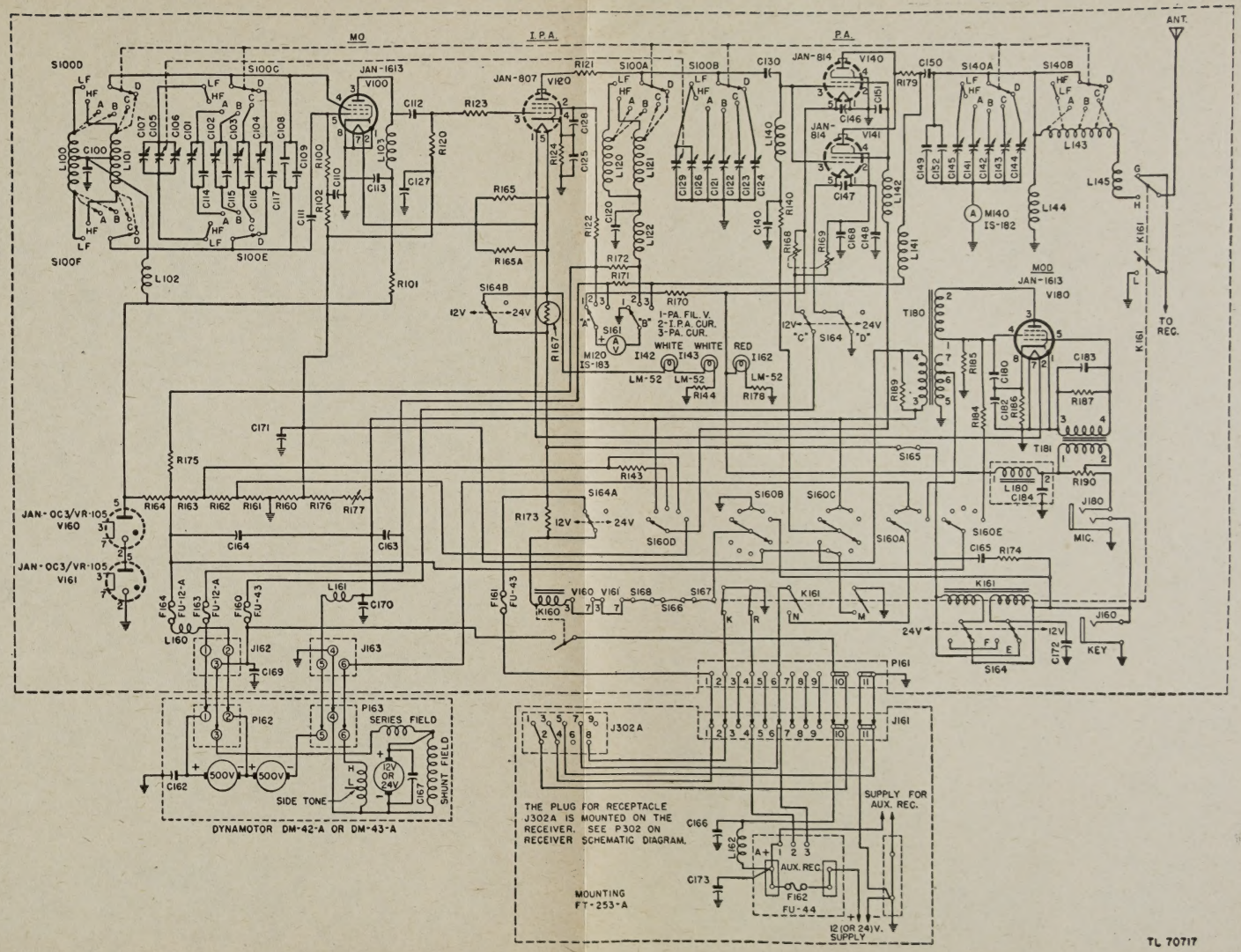

Figure 27. Over-all schematic diagram, Radio Transmitter BC–653–A.

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